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The Effects of Compound Macroeconomic Variables on Economic Growth, Evidence from North African Countries, using PARDL and the PVAR Approaches

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ABSTRACT

The empirical economic literature has relied on traditional factors such as capital and labor in explaining the causes of economic growth. However, recently, the studies used new economic concepts based on a wide number of factors expressed in compound indicators (such as index of; digitization, competitiveness, innovation, Economic Complexity, and Macroeconomic instability) to investigate their impacts on economic growth. So, the main objective of this study is to examine the effect of Economic Complexity, Economic Freedom, and Macroeconomic Instability on Economic Growth in the North African region between 1999-2019. The study used the first generation of panel unit root test (IPS, ADF, PP) To identify the individual root in Cross-Section Independence. The unit root result shows that variables GDPg and ECI are stationary at level (0) while variables EFI and MII are stationary at level (1). This study employed the PARDL and the PVAR approaches to investigate the linkages between the studied variables. Then, to clarify the direction of the relationship between the variables, we employ the Dumitrescu-Hurlin approach of causality test appropriate for panel data. The fin-dings reveal a significant long-run cointegration relationship among ECI, EFI, MII, and GDPg at the 5% significance level. Furthermore, the PVAR estimation approaches confirm that; the economic freedom index, macroeconomic instability index, and economic complexity index are significantly and positively associated with GDP growth. The empirical results also proved a critical causality from macroeconomic instability to GDP growth and passing across Economic Complexity and Economic Freedom. In this context, to boost economic growth in North African countries, economic policymakers must work on; Reducing economic instability, increasing levels of economic Complexity, and supporting economic Freedom.

INTRODUCTION

Previously, to explain and determine the reasons for economic growth, models describing economic growth relied on the Cobb Douglas production function concept, which determines how production factors such as capital and labor affect the gross domestic product. Recently, many studies have examined new determinants of economic growth. These studies used new economic concepts expressed in compound indicators (such as economic Complexity, Macroeconomic Stability) to discuss their impact on economic growth. These compound variables are composed of macroeconomic variables that have a mutual effect on the performance of the macroeconomy, which is what called for the search for the impact of such compound variables on economic growth.

The concept of Macroeconomic Stability refers to a situation of the national economy that has to avoid vulnerability to external and internal shocks, which in turn increases its prospects for sustained growth. The macroeconomic stability index consists of five variables: Low and stable inflation, low long-term interest rates, Low national debt relative to GDP, Low deficits prevent growth in the national debt, and Currency stability.

More recently (Hausmann et al., 2007) introduced the role of micro-products produced by the economy in economic growth through economic Complexity. which has attracted the attention of many economists, especially with creating a new Economic Complexity Index (ECI) by Hidalgo. & Hausmann, 2009. Hidalgo and Hausmann (2009) defined "Productive knowledge" as the sum of the complex cooperation between the individuals, institutions, and policies in a society". Productive knowledge is the economy's productive capabilities that share the concept of Economic Complexity.

Another important concept, Economic Freedom, means no barriers to business entry, business operations, and business exit. Also, Economic Freedom through the indirect impact of the creation institutions framework and environment that encourages economic development.

The analysis of the role of economic Freedom, economic Complexity, and macroeconomic stability is of great interest, proved by much research (Dornbusch and Edwards (1990); Onis (1997); Fischer, 1993; De Haan and Siermann, 1998; Hidalgo and Hausmann, 2009), especially in developed countries. Recently, many researchers have been interested in developing countries (Neffati and Sallam (2021); Güneri and Yalta (2020); Buhari et al. (2020); Ibragimov et al. (2019); Ali and Rahman (2015)) .

Especially in North African countries, which witnessed a decline in economic growth rates and high unemployment rates due to the Arab Spring revolutions, economic policymakers look for ways to advance these countries and achieve high growth rates. This paper is interested in ingredients for success to promote the current developments in North African countries. However, it is noteworthy that previous studies examined the impact of these variables individually. So, to take this shortage into account, this study contributes to the economic literature by Investigating The relationship between Economic Complexity, Macroeconomic Stability, and Economic Freedom and their role in promoting Economic Growth.

Achieving high economic growth rates remains a primary goal of economists and politicians. However, with economic growth affected by many individual and compound economic variables, the problem of the study lies in researching and explaining the role of a group of complex variables such as economic Complexity, Economic Freedom, and economic stability on economic growth.

The study will test the following hypotheses:

Hypothesis 1; Economic Complexity, Economic Freedom, and macroeconomic stability in North African countries positively impact economic growth.

Hypothesis 2; There is a causal relationship between the independent study variables.

Hypothesis 3; There is a one-way causal relationship between the independent study variables (economic Complexity, Economic Freedom, and macroeconomic stability) and the dependent variable (economic growth).

So, the main objective of this study is to examine the dynamic relationships between economic Complexity, Economic Freedom, and macroeconomic stability and between economic growth in North African

countries. To achieve the aim of this study, we will use two approaches of empirical analysis: the long and short-run Cointegration relationships and the Pairwise causality approach for the period between 1999-2019.

Besides the introduction, this study is divided into three sections: Section 2 provides a literature review. Section 3 presents the methodology, reports the estimation, and analyses the empirical results. The 4th section concludes.

1. LITERATURE REVIEW

This part aims to survey the empirical literature on the relationship between Macroeconomic instability, Economic Complexity, Economic Freedom, and Economic Growth. In addition, a nexus causality between them will be briefly outlined.

The potential and compound Capabilities are more diverse and multidimensional when compared to traditional factors of production such as labor, capital, and technology. And the ability to explain the differences in growth levels between countries.

After the original contribution by Robert Solow (1956) in economic growth theory, much research in the theoretical and empirical literature investigated the causes of growth in diverse ways. And they have concluded that there are various factors causing differences in growth levels between countries; such as) the stock of human capital (Lucas, 1988), R&D, knowledge, and ideas (Romer, 1986,1990a), government expenditure (Barro, 1990), the quality of institutions (Glaeser et al.,2004), etc...

In the last two decades of economic literature, several studies which sought the reasons for enhancing economic growth abandoned the Investigation of partial variables (e.g., innovation, knowledge, education, etc.). Instead, it headed for the use of global or composite indicators consisting of macroeconomic variables, such as Digitization (Katz and Koutroumpis,2012), economic Complexity (Hidalgo and Hausmann,2009), economic Freedom (De Haan and Siermann,1998), Economic stability (Fischer,1993).

Neffati and Sallam (2021) investigated the relationship between macroeconomic (in)stability and economic growth. First, through how to measure macroeconomic instability. Secondly, determine the determinants of macroeconomic (in)stability and some economic characteristics of North African countries. Finally, the results achieved through econometric analysis refer that trade, investment, and monetary policy are important factors in achieving macroeconomic stability.

Fisher (1993) examined the role of macroeconomic factors in growth by choosing some indicators (inflation rate, public deficit, and black-market exchange rate premium) as an initial attempt to measure the degree of macroeconomic stability in the empirical analysis. And on the same approach, Sanchez (1998) emphasize the role of economic stability in achieving economic growth in the Spanish and Ukraine experience.

By using the dataset from the global competitiveness report, Global Environmental Performance Index, and World Data Bank for 7 European countries (Moldova, Poland, Ukraine, Georgia, Latvia, Belarus, and Lithuania), Ibragimov et al. (2019) reached the same result, emphasized the effect of macroeconomic stability, environmental performance on economic growth.

Dornbusch and Edwards (1990) and Onis (1997) conclude that there is a negative relationship between macroeconomic instability and economic growth, and supporting these findings, Easterly and Kraay (2000), through cross country study, reached that macroeconomic stability and economic growth are positively related to each other. The empirical results of Ali and Rahman (2015) confirm that the availability of a stable macroeconomic environment contributes to achieving the desired level of gross domestic product.

Economic development is the product of accumulating stages of economic Complexity. The Studies presented by Hidalgo et al. (2007) and Hidalgo and Hausmann (2009) explained that economic development is a product of the overall Complexity of a country's productive structure.

By examining the relationship between economic Complexity and growth in the short and long term, Stojkoski and Kocarev (2017) found that economic Complexity Illustrates changes in growth in the long

run. While in the short run, this effect does not appear. And thus, all of this reveals that Economic Complexity requires to develop the long-run strategies in the countries for inventing products and achieving growth rates and sustainable growth.

In this context, Buhari et al. (2020) have shown that economic Complexity and other factors (FDI, institutional quality, trade openness, renewable energy consumption) promote economic growth.

In an attempt to find a relationship between the high-income level and the degree of economic Complexity, Felipe et al. (2014) presented their study, which concluded that there is a close relationship between rich countries (high-income level) and increasing the degree of economic Complexity. Furthermore, this result proved the countries' production structures in varying income levels.

As is known, fluctuations in production affect growth rates, and reducing these fluctuations will positively impact growth. To show the role of economic Complexity as a useful tool in reducing production volatility in developing countries. Güneri and Yalta (2020) used a sample of 61 developing countries between 1981 and 2015. The findings robust that economic Complexity affects output volatility negatively.

Britto et al. (2019) compared South Korea and Brazil, which have similar average per capita GDP levels, to prove the role of economic Complexity in bringing about economic development. Their findings constat that South Korea specialized in products and fields more complex and intensive in technologies. So, it has faster growth rates than Brazil.

To study the enabling environment for economic growth based on the premise that greater economic Freedom leads to higher levels of economic growth, based on Adam Smith's theory of the market's invisible hand. If it is allowed to operate in an environment of Economic Freedom, it will perform an effective task in allocating resources. Therefore, public policy will not be concerned with capital production, technology integration, or the development of a skilled workforce if such an enabling environment is created. Instead, the economy will attract investment and incentivize workers to acquire marketable skills and adopt more advanced technology because this right environment will attract the right inputs. Growth will follow if growth policy focuses on creating an environment of economic Freedom. Without the right environment, growth will not occur.

Economists have resorted to looking for economic Freedom as explanatory variables in countries that are similar in factors of production and have different growth rates. Based on Gwartney et al. (1996), Sturm and De Haan (2001) and, Gwartney et al. (2012), economic Freedom is defined as a personal choice, accompanied by having the right to own property and protection of these rights besides free entry to the market, Freedom of competition. Voluntary activities are carried out in the markets. Gwartney et al. (2010) indicate that economic Freedom has five important components identified by the Fraser Institute. (a) freedom of international trade, (b) regulation of credit, work, and business, (c) access to sound money, (d) size of government, (e) legal structure, and security of property rights .

Akin et al. (2014) conducted their study on five different income categories to investigate the effect of Economic Freedom on economic growth. The study results confirmed a significant and positive relationship between the income group's Economic Freedom and Economic Growth level.

The next part of the paper seeks to achieve this study's aim using a cross-section panel approach.

2. EMPIRICAL STUDY

2.1 Methodologies, Data, and variables Descriptions

The dynamic linkage between Economic Growth, Economic Complexity, Macroeconomic Stability, and Economic Freedom will be analysed based on annual panel data from four North African countries spanning 1999 to 2019. the methodology requires several steps to investigate how economic Complexity, Economic Freedom, and macroeconomic instability are interrelated with economic growth. First, identify short and long-run cointegration relationships between these composite variables. Secondly, using an empirical analysis based on an (ARDL), (VAR), and Granger causality approach, the nature of the observed relationship between economic growth and some of the explanatory variables is detected. The source of data used

is from the World Bank database, Observatory of Economic Complexity, and The Heritage Foundation's Center for International Trade and Economics (CITE).

Economic Complexity Index (ECI)

The original formulation to measure Economic Complexity was created by Hidalgo and Hausmann (2009) from the Massachusetts Institute of Technology (MIT) and Harvard University's Kennedy School of Government. The Economic Complexity Index (ECI) is a composite index, a proxy of the degree of Economic Complexity.

The ECI data is available in The Observatory of Economic Complexity. Hidalgo and Hausmann et al. (2009) propose the concept of ECI as a descriptive measure and predictive tool for economic growth and income inequality. According to the statistics models presented in their Atlas of Economic Complexity. Complexity Economic Index takes the following formula:

$$ECI_c = \frac{K_c - \widetilde{K}_c}{\sigma(K_c)}$$

Where $\widetilde{K}_c$ is the average of K_c and $\sigma(K_c)$ is the standard deviation of K_c(OCE).

Economic Freedom Index (EFI)

We measure economic Freedom based on 12 quantitative and qualitative factors. The Index of Economic Freedom evaluates the extent and effectiveness of government activity in 12 areas that significantly impact economic growth and prosperity levels. The key ingredients of economic Freedom determined by The Heritage Foundation are grouped into four broad categories or pillars of economic Freedom:

- Rule of Law (property rights, government integrity, judicial effectiveness).
- Government Size (government spending, tax burden, fiscal health).
- Regulatory Efficiency (business freedom, labor freedom, monetary Freedom).
- Open Markets (trade freedom, investment freedom, financial Freedom)

Each of the twelve Economic Freedoms within these categories is graded on a scale of 0 to 100. A country's overall score is derived by averaging these twelve economic freedoms, giving equal weight to each.

Macroeconomic Instability Index (MII)

Most empirical studies used a composite index to measure macroeconomic stability. This study is based on the macroeconomic stability index (MII), developed by Neffati and Sallam (2021). The index takes the following formula:

$$MII_{it} = \sum_{j=1}^{5} w_{ij} \left(\frac{X_{itj} - \min X_{ij}}{\max X_{ij} - \min X_{ij}} \right)$$

The weighted weight w_{ij} It is calculated by using the standard deviation of the variable (j) for all the periods (1999-2019) for each country (i).X_{tij}= the normalized value of each variable in each country in each period.

This paper will apply these composite indexes to determine the impact of economic Complexity, Economic Freedom, and macroeconomic instability on economic growth in four North African countries from 1999 to 2019.

Usually, the Cobb-Douglas function is used in applied studies of economic growth. Still, this study will directly test the relationship between the composite factors (study variables) and economic growth without adding the traditional economic growth variables (capital and labor) in the Cobb-Douglas function. Because the main objective of this paper is to test Cointegration and the causal relationships between economic growth and the new variables adopted. To implement these steps, the empirical model used to test the relationship between economic Complexity, economic Freedom, macroeconomic instability, and economic growth can be specified by a simple model as follow:

$$GDP_g = F\ (ECI, EFI, MII\ )$$

Where GDPg, is the annual rate of economic growth, ECI is the economic Complexity, EFI is the Economic Freedom Index, and MII is the economic stability index. Therefore, there is expected to be a direct relationship between the explanatory variables ECI, EFI, MII, and the dependent variable (GDPg).

2.2 The Panel Unit Root Tests

Many developed tests have recently appeared to analyze the unit root of the panel data and examine it. For example, Pesaran (2003, 2007) develops simple tests of error cross-section dependence applicable to various panel data models. The unit root test literature is related to the correlation between individuals (Cross-Section independence or Cross-Section dependence). The question is whether it is possible to allow the existence of a correlation between the rest of the various individuals in the panel. Two generations of panel unit root tests can be distinguished: The first generation assumes cross-section units are cross-sectionally independent (IPS, ADF and PP.). In comparison, the second generation of panel unit root tests relaxes this assumption allowing for cross-sectional dependence (CIPS and CADF).

Cross-Section Independence Test.

To identify the individual root in Cross-Section Independence, we use the first generation of panel unit root test (IPS, ADF, PP.). Table 1 present the relative result.

Tables 1. Results of the panel unit roots test (Cross-Section Independence Test)

Null: unit root (assumes common unit root process)				
In level	EFI	MII	GDPg	ECI
Im, Pesaran and Shin W-sta	-0.503 (0.308)	0.993 (0.840)	-2.877* (0.002)	-2.927* (0.002)
ADF - Fisher Chi-square	8.269 (0.408)	3.538 (0.896)	24.106* (0.002)	23.075* (0.003)
PP - Fisher Chi-square	11.548 (0.173)	2.887 (0.941)	32.649* (0.000)	11.416* (0.179)
In first difference	ΔEFI	ΔMII		
Im, Pesaran and Shin W-stat	-3.218* (0.001)	-2.218* (0.013)		
ADF - Fisher Chi-square	24.286* (0.002)	17.591* (0.025)		
PP - Fisher Chi-square	63.881* (0.000)	38.187* (0.000)		

Note: * The rejection of null hypothesis at 5%. And (.), P-value.

The unit root result presented in table (1) shows that variables GDPg and ECI are stationary at level (0) while variables EFI and MII are stationary at level (1). Because EFI and MII variables are not stationary in I(0) and are stationary in their first difference, long-term relations between variables are examined with co-integration tests and short-term relations with error correction tests. According to this result, to Investigate the nexus between Economic Complexity, Economic Freedom, Macroeconomic instability, and economic growth in North African Countries, we apply two mothed: Panel Vector autoregressive model (PVAR) and Panel Autoregressive distributed lag (PARDL).

Cross-Section Dependence Test (CIPS and CADF unit root tests)

Preliminary to proceed with the Granger causality analysis, it is necessary to choose a suitable model, referring to the procedure of the stationarity test of variables used (ECI, EFI, MII, and GDPg). The first-generation panel unit root tests are the most often used. Still, they are sensitive to the cross-sectional dependence that emerges from shocks common to countries' groups or spillovers across countries. Moreover, the asymptotic convergence to the normal distribution of the first-generation panel unit root tests' estimators assumes that all the panel units are independent, so these first-generation tests are unreliable if there is cross-sectional dependence. To avoid this problem, we use a second-generation panel unit root test developed by Pesaran (2007), based on the Im, Pesaran, and Shin (2003) unit root test.

Further, Pesaran's method (2003) is based on augmenting the usual ADF regression with the lagged cross-sectional mean. And its first difference is to capture the cross-sectional dependence that arises through a single-factor model. Finally, Pesaran (2007) proposes a simple alternative where the standard augmented Dickey-Fuller (ADF) regressions are augmented with the cross-section averages of lagged levels and first differences of the individual series.

According to Pesaran (2007, p283), This is called the Cross-sectionally Augmented Dickey-Fuller test (CADF) to detect the presence of a unit root. We estimate the CADF and CIPS unit root test based on the following equation:

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + c_i \bar{y}_{t-1} + \sum_{j=0}^{p} d_{ij} \Delta \bar{y}_{t-j} + \sum_{j=1}^{p} \delta_{ij} \Delta y_{i,t-j} + \varepsilon_{it}$$

Where $\bar{y}$ The average at time t of all observations, a, b, c, d, δ are parameters, i number of countries, and j number of variables.

After running this CADF regression for each country (i) in the panel, Pesaran averages the t-statistics on the lagged value (called $CADF_i$) to obtain the CIPS statistic. Experimental results show that these tests perform well

$$CIPS = \frac{1}{N} \sum_{i=1}^{N} CADF_i$$

In the case of cross-sectional dependence, traditional unit root and Cointegration tests may produce biased results. Therefore, different tests were used to measure the cross-sectional dependence, CIPS, and CADF unit root tests.

For instance, the cross-sectional dependence (CD) test is helpful in the case of large N and small T in the panel data (Pesaran 2004).

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i-1}^{N-1} \sum_{J=I+1}^{N} p_{ij} \right)$$

In contrast, the LM test was applied for panel data with large T and small N. Herein, we used Breusch, Pagan LM test, Pesaran CD test, and Pesaran scaled LMtest for reliable results (Breusch and Pagan, 1980). The result provides reinforcing proof to discard the null hypothesis of cross-sectional dependence as the relevant p-value is below 0.01. Avoid obtaining biased results when using traditional unit root tests and co-integration in panel data models. Cross-sectional dependence tests should be performed before starting unit root tests for the variables of this study. So, in this study, we use the Breusch-Pagan LM test, and Pesaran scaled LM test to measure the cross-sectional dependence and reliable results.

Table 2. Results of the panel unit roots test:

a-Cross-Section Dependence Test

Null hypothesis: No cross-section dependence (correlation)		
variables	Breusch-Pagan LM	Pesaran scaled LM
GDPg	*9.017* *(0.173)*	*0.871* *(0.384)*
ECI	*82.908** *(0.000)*	*22.202** *(0.000)*
EFI	*13.523** *(0.035)*	*2.172** *(0.029)*
MII	*32.869** *(0.000)*	*7.756** *(0.000)*

Note: * The rejection of null hypothesis at 5%. And (.), P-value.

b- Cross- Sectionally Dependent Panels

Variables	Country	Constant	Constant with trend
		CADF Unit Root Tests	
GDPg	Algeria	-1.85***	-3.19***
	Egypt	-1.41***	-1.64***
	Morocco	-1.74***	-4.08***
	Tunisia	-5.47	-3.21***
ECI	Algeria	-0.93***	-3.28***
	Egypt	-0.32***	-1.79***
	Morocco	-1.91***	-3.40***
	Tunisia	-0.21***	-3.79***
EFI	Algeria	-1.12***	-4.27***
	Egypt	-3.55***	-2.91***
	Morocco	-0.74***	-5.10
	Tunisia	-4.01	-4.67***
MII	Algeria	-1.59***	-3.55***
	Egypt	-3.03***	-2.02***
	Morocco	-3.88***	-3.43***
	Tunisia	-1.45***	-5.23
Variables		CIPS Unit Root Tests	
GDPg		-2.62	-3.03***
ECI		-0.84***	-3.06***
EFI		-2.36***	-4.24
MII		-2.49***	-3.56

The null hypothesis of CADF and CIPS unit root tests is non-stationarity. At constant, the critical values are −2.6, at 1% (***) significance levels. At trend and constant, the critical values are −3.15 at 1% (***) significance levels

The *tables (2a,2b)* display a cross-sectional relationship between ECI, EFI, MII, and GDPg. We used the Cross-sectional Augmented Dickey-Fuller (CADF) and Cross-sectional of Im, Pesaran, and Shin (CIPS) panel unit root test developed by Pesaran (2003, 2007). CIPS and CADF tests work under the postulation of the cross-sectional dependence.

2.3 Panel Cointegration tests and ARDL estimation

After analyzing the stationarity of studied variables, the next step consists of the determinant of the lag length order to know the right order of the estimated model, as shown in table (2.b). Order 1 is the optimal Lag length. To verify that it is the optimal Lag length, a VAR Residual Serial Correlation LM Test is performed. Finally, we accept the Null hypothesis through the value of probability, which means no auto-correlation.

Table 3. VAR Lag Order Selection Criteria

Endogenous variables: GDPG ECI EFI MII
Sample: 1999 2019

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	-310.8902	NA	0.220650	9.840320	9.975250	9.893476
1	-134.2134	325.7479*	0.001457*	4.819169*	5.493820*	5.084948*
2	-123.2803	18.79135	0.001718	4.977508	6.191880	5.455911
3	-118.3833	7.804617	0.002469	5.324477	7.078569	6.015502

* indicates lag order selected by the criterion

Source: own

VAR Residual Serial Correlation LM Tests

**Null hypothesis: No serial correlation at lags 1 to h

Lag	*LRE stat*	*Prob.*
1	17.15450	0.3757
2	32.74987	0.4300
3	41.88495	0.7204

**Here, we accept the Null hypothesis mean that there is no autocorrelation

According to the parsimonious principle, First-period lag is considered the best lag length. The selection of the right lag length based on the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and Hannan-Quinn Information Criterion (HQIC), is summarized in table 3.

The lag length value equals (1) main, with no residual autocorrelation. Those conditions permitted us to use cointegration tests.

The extensive interest and the availability of panel data have led to an emphasis on extending various statistical tests to panel data. As a result, recent literature has focused on cointegration tests in a panel setting. There are several testing procedures available for panel cointegration use, such as Kao (1999), Pedroni (1999, 2004), Fisher-type test using an underlying Johansen methodology (Maddala and Wu 1999), and Westerlund (2007). This study uses the first three tests to test the cointegrating relationship between Economic Complexity, Economic Freedom, Macroeconomic instability, and economic growth in North African Countries during 1999-2019.

Table 4. Cointegration Panel Test

Cointegration Panel Test types	*types*	*t-stat*	*Prob.(p-value)*	*No. of CE(s)*
Fisher	Fisher Stat. (trace test)	54.87	0.0000	None
		26.22	0.0010	At most 1
		16.04	0.0418	At most 2
	Fisher Stat. (max-eigen test)	36.35	0.0000	None
		14.93	0.0604	At most 1
Pedroni	Panel PP- Stat.	-3.546	0.0002	
	Panel ADF- Stat.	-3.803	0.0001	
Kao	ADF	-3.254	0.0006	

Source: own

Table 4 shows the short-run and long-run causal relationships that were also investigated using the panel error correction model.

Table 5. Panel ARDL estimation

Dependent Variable: D(GDPg)		
Method: PARDL (1, 1, 1, 1)		
Long Run Equation		
Variable	Coefficient	Prob.*
ECI	-1.338251**	0.0274
EFI	0.080312***	0.0000
MII	-3.398203***	0.0009
Short Run Equation		
Variable	Coefficient	Prob.*
COINTEQ01	**-0.723546****	**0.0340**
D(ECI)	1.922396	0.5297
D(EFI)	0.035038	0.8014
D(MII)	-3.184606	0.2120

Source: own

The results of the co-integration test presented in table (5) indicate a cointegration relationship in the long term between the variables of the study. But, in the short run, there is no cointegration relationship. This result was confirmed by the value of the error correction coefficient (-0.724), which means that it can return to the equilibrium position again after 1.3 years.

According to the estimation results (table 5), there is a significant long-run relationship among ECI, EFI, MII, and DGPg at the 5% significance level .

The relationship between Economic Freedom and economic growth is positive. This result agrees with *Hypothesis1*. Although the results appear that economic Complexity has a negative relationship with GDP growth rate, it concurs with *Hypothesis 1*. Because the value of the economic complexity index for those countries was negative throughout the study period ,at the same time, macroeconomic instability negatively impacts the GDP growth rate. These findings mean that the increase in macroeconomic instability decreases the GDP growth rate.

2.4 The panel VAR model (PVAR)

Researchers used the PVARs approaches to deal with dynamic models involving heterogeneous units in the empirical literature. To show how structural time variation can be handled and illustrate the challenges to researchers interested in studying cross-unit dynamics interdependences in heterogeneous set-ups. Moreover, Canova and Ciccarelli (2013) prove that the PVARs model is currently at the core of

discussions in academics and the policy area because of some advantages, they can: (i) capture both static and dynamic interdependencies, (ii) treat the links across units in an unrestricted fashion, (iii) easily incorporate time variations in the coefficients and the variance of the shocks, and (iv) account for cross-sectional dynamic heterogeneities. They also argue that the panel VARs can become an essential means to answer relevant economic questions that do not require the specification of the entire economic structure. For all these reasons, we use the panel VAR model, which is written in general form as fellow:

$$Y_{it} = A_{0i}(t) + A_i(l)Y_{t-j} + u_{it} \qquad (1)$$

As our case study is limited to four north African countries, where i=1, 4 (countries) and t= 1999, 2019 (years), the equation (1) can be rewritten for the PVAR model as follow:

$$GDPg_{it} = A_{11}(t) + A_{12}(l)ECI_{t-j} + A_{13}(l)EFI_{t-j} + A_{14}(l)MII_{t-j} + u_{1t} \text{ (M1)}$$

$$ECI_{it} = A_{21}(t) + A_{22}(l)GDPg_{t-j} + A_{23}(l)EFI_{t-j} + A_{24}(l)MII_{t-j} + u_{2t} \text{ (M2)}$$

$$EFI_{it} = A_{31}(t) + A_{32}(l)GDPg_{t-j} + A_{33}(l)ECI_{t-j} + A_{34}(l)MII_{t-j} + u_{3t} \text{ (M3)}$$

$$MII_{it} = A_{41}(t) + A_{42}(l)GDPg_{t-j} + A_{43}(l)ECI_{t-j} + A_{44}(l)EFI_{t-j} + u_{4t} \text{ (M4)}$$

Table 6. PVAR model regression results

Vector Autoregression Estimates, Sample (adjusted): 2000-2019				
	M1	M2	M3	M4
	GDPg	ECI	EFI	MII
GDPg (-1)	0.3347*** (2.98950)	-0.008957 (-1.39702)	0.041200 (0.30897)	-0.0150** (-2.38087)
ECI (-1)	-0.193907 (-0.31339)	0.9859*** (27.8254)	0.998178 (1.35456)	0.0695** (2.00005)
EFI (-1)	0.034209 (0.61518)	0.003983 (1.25062)	0.8544*** (12.9016)	8.02E-06 (0.00257)
MII (-1)	0.085357 (0.09282)	-0.035332 (-0.67096)	-0.357413 (-0.32636)	0.8498*** (16.4540)
C	0.387452 (0.11936)	-0.173280 (-0.93218)	8.3488** (2.15959)	0.158880 (0.87148)
R-squared	0.117355	0.923857	0.725643	0.821707
F-statistic	2.492976	227.4978	49.59157	86.41401
Log likelihood	-156.3396	72.46519	-170.3203	74.01898
Akaike AIC	4.033490	-1.686630	4.383007	-1.725475
Mean dependent	3.705894	-0.392190	56.38500	0.413390
S.D. dependent	1.829444	0.356689	3.907963	0.228613
Determinant resid covariance (dof adj.)		0.001313		
Determinant resid covariance		0.001014		
Log-likelihood		-178.3135		
Akaike information criterion		4.957837		
Schwarz criterion		5.553344		
Number of coefficients		20		

Included observations: 80 after adjustments, Standard errors in ( ) & t-statistics in ( )

Source: own

Table 6 summarizes the results of the PVAR estimation for the four equations (M1-M2-M3-M4) that show the dynamic relationships between the study variables. Under the significance level (1%), all variables

are positively affected by their levels in the previous periods. This result means that enhancing the values of these variables positively affects their cumulative growth events.

Dynamic relationships appear at the 5% level of significance between these variables. Economic growth significantly and positively impacts achieving more economic stability (M4). Economic Complexity also contributes to achieving high levels of Economic stability (M4). In light of the significance and positive effects of economic growth and Complexity on Economic stability, we find that Economic stability, in turn, has a significant and positive impact on Economic stability (M3). Economic Freedom and Economic Stability create an economic environment conducive to achieving sustainable growth rates, encouraging many institutions for Economic stability.

2.4.1 Impulse Response Function

We used the impulse response function analysis of four variables to analyze the dynamic relationship between variables. This graph illustrates the impact of a standard random perturbation shock on the other variables and can explore the dynamic relationship and interaction between variables.

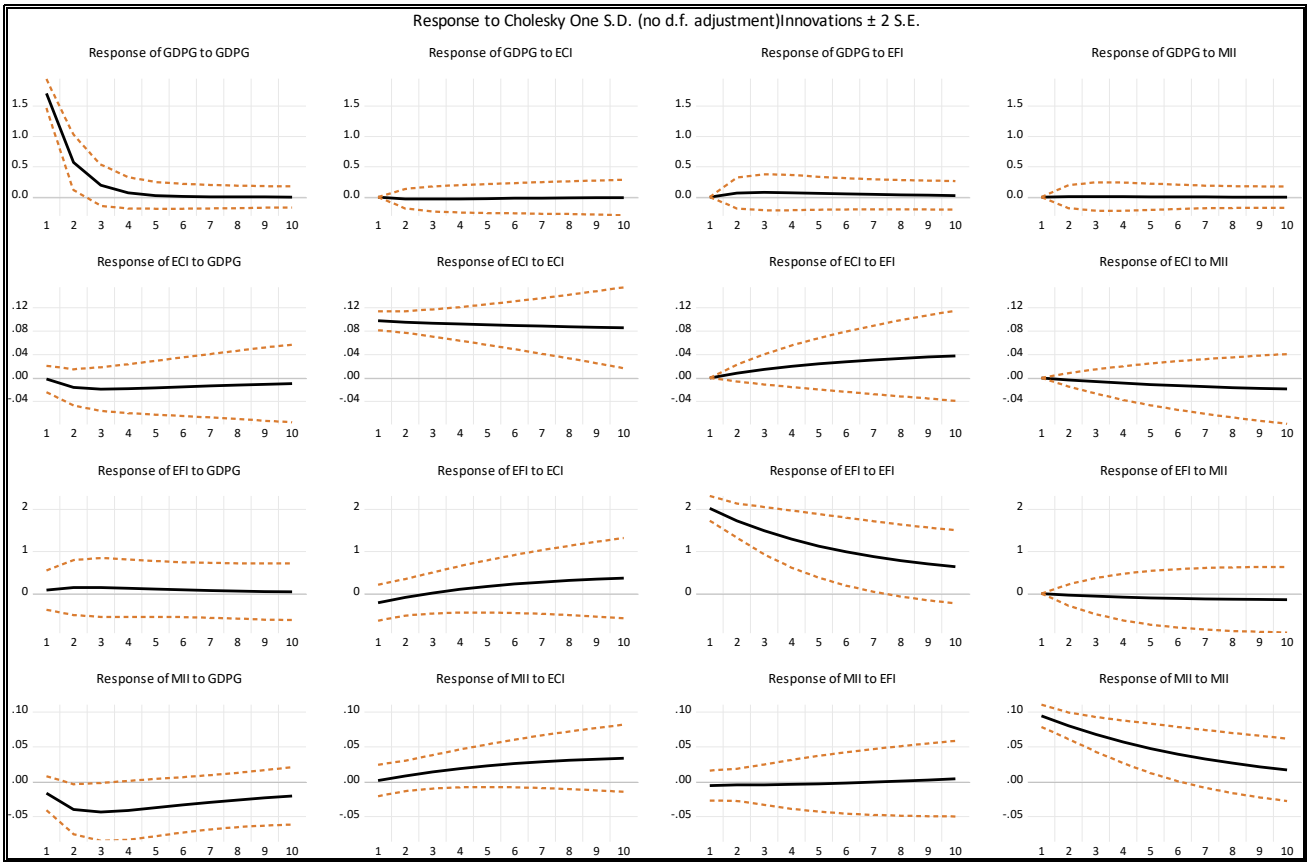

Figure1. Impulse Response multiple graphs
Source: own

The most important results that can be extracted from Fig. (1) are as follow:

- Row1 presents the responses of GDP growth to the shocks of other variables. The GDPg variable shows a negligible positive response to ECI, EFI, and MII shocks. This result is clearly shown in Figure (2-a) Impulse Response combined graphs, meaning that changes in economic Complexity, Economic Freedom, and economic stability are taking place slowly.

– Row2, which is combined in fig. (2-b), ECI negatively responds to the shocks in GDPg and MII. In contrast, it reacted positively to the EFI shocks. Economic Freedom generally refers to the economy's ability to attract more foreign investment, increasing the degree of Complexity of products and services.

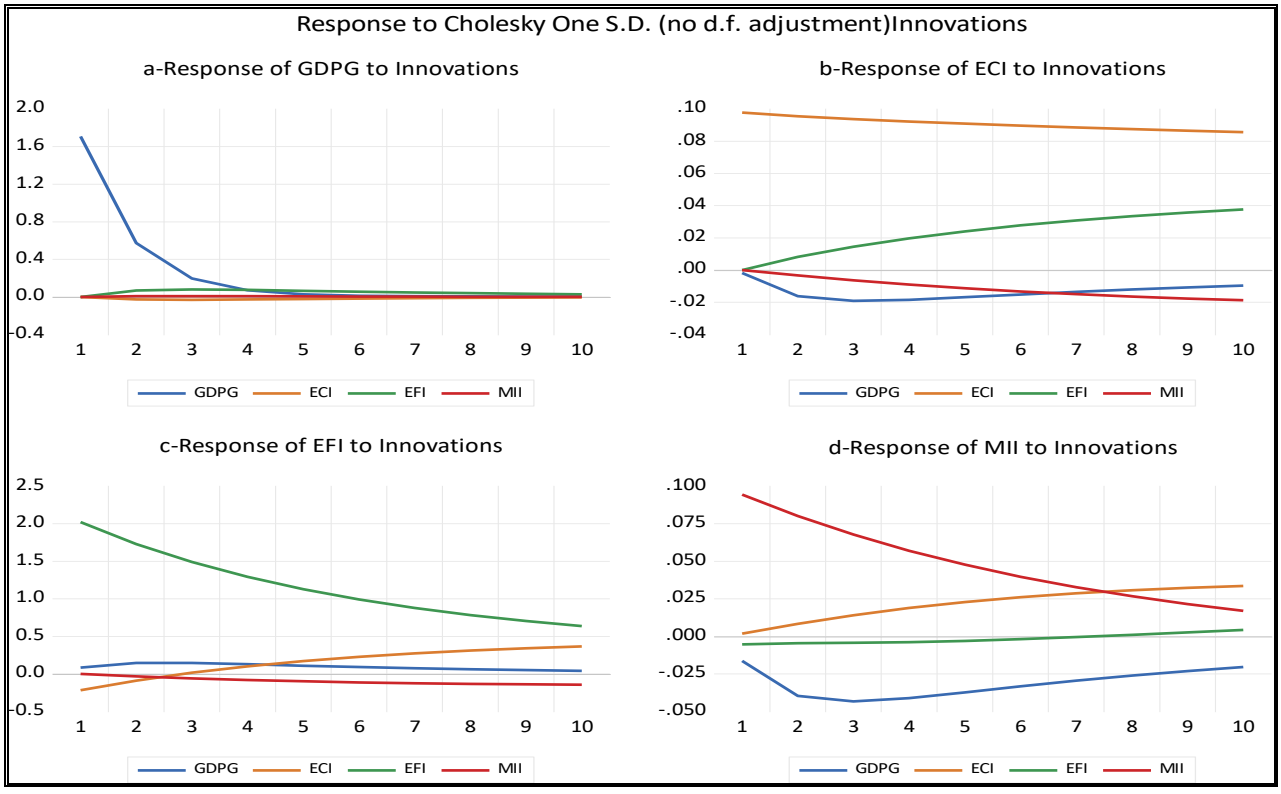

Figure 29. Impulse Response combined graphs (Cholesky One S.D. (d.f. adjusted)

Source: own

Thus, it can be said that economic Freedom has a positive effect on economic Complexity, and at the same time, economic Complexity also positively affects economic Freedom. Therefore, the increase in the degree of economic Complexity of the state encourages the strengthening and consolidation of facilities that produce products that raise the degree of economic Complexity of the country.

The results obtained from the ARDL Panel model in the short term indicate no relationship between the independent variables of the study (ECI, EFI, MII) and the dependent variable (GDPg). This result is consistent with the results derived from the Impulse Response Function (IFRS), which indicates that (GDPg) is not affected by the shocks that occur in (ECI, EFI, MII). Also, this result means that changes related to economic Complexity, Economic Freedom, and economic stability are taking place slowly.

2.4.2 The variance decomposition of variables

The Variance Decomposition results summarized in table 7 and presented in figure 3 confirm the results obtained from the analysis of the Impulse Response Function above. In which:

Variance decomposition of the GDP growth indicates that own shock for the whole period of about 98% of the changes in the GDP, where the economic Freedom contributes approximately 1%, the economic Complexity share nearly 0.1%, and the Macroeconomic Stability shares account for 0.001%.

Variance decomposition of the economic Complexity indicates that own shock for the first period, 99.9% of the changes in the economic Complexity. But at the end of the period, Variance decomposition of the economic Complexity indicates that own shock 81% of the changes in the economic Complexity. In addition, economic Freedom contributes approximately 14%, Macroeconomic Stability shares account for 3.5%, and GDP growth contributes 1.3%.

The analysis of economic freedom variance does not differ from the analysis of variance of Economic Complexity. Variance decomposition of the Economic Freedom indicates that own shock for the first period, 98.7% of the changes in the economic Freedom. But at the end of the period, Variance decomposition of the economic Freedom indicates that own shock 86% of the changes in the economic Freedom, while economic Complexity contributes approximately 12%, the Macroeconomic Stability shares account for 1.7%, and the GDP growth contributed 0.5%.

Variance decomposition of the Macroeconomic Stability indicates that own shock for the first period, 96.7% of the changes in the Macroeconomic Stability. But at the end of the period, Variance decomposition of the economic Complexity indicates that own shock 48% of the changes in the Macroeconomic Stability, while economic Complexity contributed approximately 30%, the GDP growth contributed 19%, and the Macroeconomic Stability shares account for 2.5%.

Table 7. The variance decomposition of variables results

Variance Decomposition of GDPg:					
Period	S.E.	GDPg	ECI	EFI	MII
1	1.763985	**100.0000**	0.000000	0.000000	0.000000
5	1.880273	**99.27872**	0.082245	0.631436	0.007597
10	1.883045	**98.99532**	0.100922	0.894616	0.009138
15	1.883564	**98.94134**	0.101304	0.948175	0.009181
20	1.883724	**98.92461**	0.103460	0.962458	0.009474
Variance Decomposition of ECI:					
Period	S.E.	GDPg	ECI	EFI	MII
1	0.101015	0.033204	**99.96680**	0.000000	0.000000
5	0.223909	2.665723	**94.13357**	2.652584	0.548123
10	0.314974	2.167424	**88.82563**	7.300363	1.706584
15	0.384537	1.638608	**84.49591**	11.12870	2.736779
20	0.441684	1.296613	**81.27463**	13.91145	3.517305
Variance Decomposition of EFI:					
Period	S.E.	GDPg	ECI	EFI	MII
1	2.100833	0.167429	1.135015	**98.69756**	0.000000
5	3.640842	0.629234	0.758304	**98.44128**	0.171183
10	4.167075	0.615876	3.499077	**95.23230**	0.652743
15	4.445055	0.554855	7.668503	**90.58260**	1.194038
20	4.657893	0.505811	11.81053	**86.00913**	1.674531
Variance Decomposition of MII:					
Period	S.E.	GDPg	ECI	EFI	MII
1	0.099072	2.908472	0.033794	0.314780	**96.74295**
5	0.189012	20.28887	3.438842	0.275059	**75.99723**
10	0.221192	22.69772	12.58348	0.265350	**64.45345**
15	0.240088	21.24010	22.47560	0.946693	**55.33760**
20	0.257479	18.98556	30.36074	2.464827	**48.18887**
Cholesky Ordering: GDPg ECI EFI MII					

Source. own

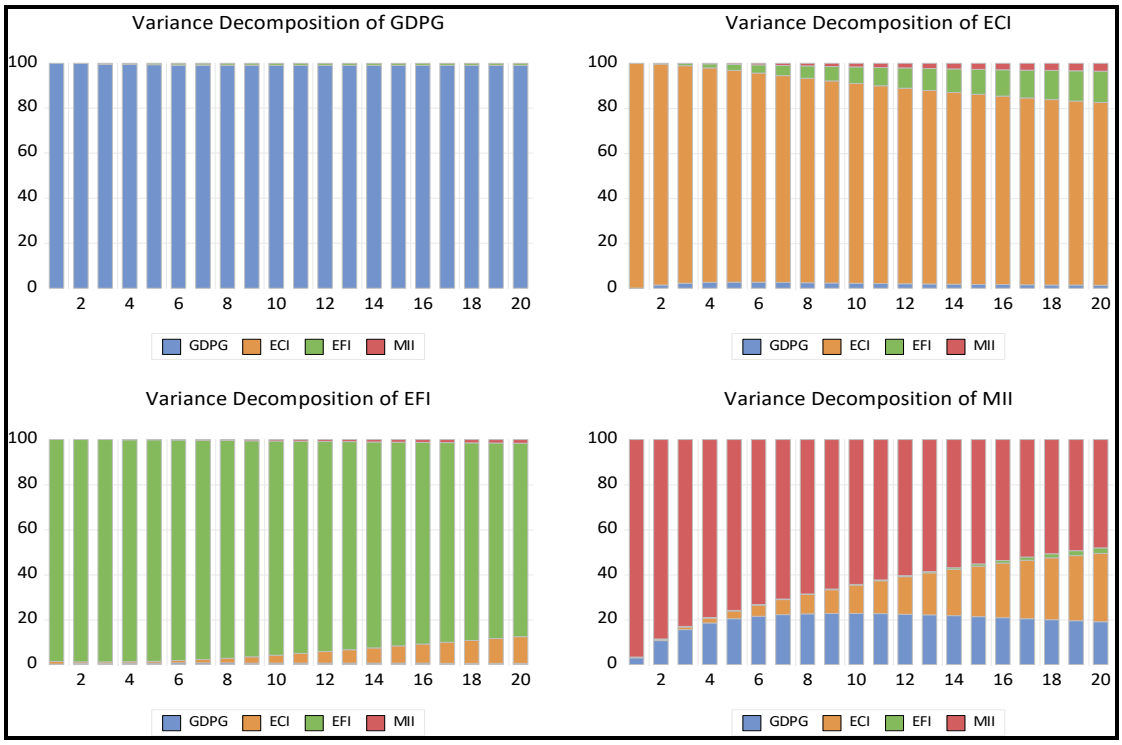

Figure 3. Variance decomposition of variables, tacked graphs using Cholesky (d.f. adjusted) Factors

Source: own

2.5 Panel Causality Tests

a. Pairwise Dumitrescu Hurlin Panel Causality Tests

In a seminal paper, Granger (1969) developed a methodology for analyzing the causal relationships between time series. Dumitrescu and Hurlin (2012) provide an extended test to detect causality in panel data. Consider, in our case, GDPg and X as stationary variables noted *t* periods and *N* individuals. For each individual *i* and each period *t*. the underlying regression writes as follows:

$$GDPg_{it} = \alpha_i + \sum_{k=1}^{k} \beta_k GDPg_{it-k} + \sum_{k=1}^{k} \gamma_k X_{it-k}^{'} + \varepsilon_{it}$$

$$X_{it}^{'} = \theta_t + \sum_{k=1}^{k} \delta_k X_{it-k}^{'} + \sum_{k=1}^{k} \rho_k GDPg_{it-k} + \mu_{it}$$

Where, $X_{it}^{'}$, replace ECI_{it}, EFI_{it}, MII_{it} , and i=country, t=year

Table 8. Pairwise Dumitrescu Hurlin Panel Causality Tests

Dependent variable:	*MII*		*ECI*		*EFI*		*GDPg*	
Excluded	Chi-sq	Prob.	Chi-sq	Prob.	Chi-sq	Prob.	Chi-sq	Prob.
MII	--		**4.9142*** **	**0,0000**	0.5676	0.5703	0.67997	0.4965
ECI	-0.7484	0.4542	--		**5.1757*** **	**0.0000**	0.61618	0.5378
EFI	0.8340	0.4043	-0.1620	0.8713	--		**3.0348*** **	**0.0024**
GDPg	0.7420	0.4581	1.5586	0.1191	-0.7161	0.4740	--	

Note: *** indicates significance at 1%.

Source: own

According to the Pairwise Dumitrescu Hurlin Panel Causality Tests in table 8, there are intertwined and successive causal relationships that would lead to economic growth. First, macroeconomic stability is a one-way causal relationship to economic Complexity. This relationship moves from economic Complexity to economic Freedom, and finally, economic Freedom to economic growth.

Last, it can be said that macroeconomic stability doesn't emerge immediately, but it indirectly affects economic growth through Economic Complexity and Economic Freedom.

b. Pairwise Granger Causality Tests

Table 9. Pairwise Granger Causality Tests

⇩	*MII*		*ECI*		*EFI*		*GDPg*	
	F-stat.,	Prob.	F-stat.,	Prob.	F-stat.,	Prob.	F-stat.,	Prob.
MII	--		0.10070	0.7519	0.01780	0.8942	0.01139	0.9153
ECI	**4.06143**	**0.0474** **	--		1.72056	0.1935	0.01374	0.9070
EFI	0.16035	0.6899	1.27415	0.2625	--		0.31866	0.5741
GDPg	**5.42928**	**0.0224** **	1.46453	0.2299	0.09975	0.7530	--	

Note: - (**) indicate significance at 5%.

- Null Hypothesis: does not Granger Cause

Source: own

The results of the Granger causality test, summarized in table 9, confirm the previous result of the Dumitrescu Hurlin test, as there is a direct effect from economic Complexity to macroeconomic stability as well as from macroeconomic stability to economic growth. Also, according to the Granger Causality test Among Macroeconomic instability, Economic Complexity, Economic Freedom, on Economic Growth.

Therefore, the decline in levels of Macroeconomic stability in North African countries had a negative impact on both economic Complexity, Economic Freedom, and economic growth.

CONCLUSION

This paper estimates the impact of Causality Among Macroeconomic instability, Economic Complexity, and Economic Freedom on Economic Growth in four north African countries using the appropriate panel data approach spanning 1999-2019.

We empirically study the cointegration relationship, the causal effect, and the long run. This study employed Empirical approaches based on the following tests: first, we employ the Breusch-Pagan LM test and cross-sectional augmented Im-Pesaran-Shin (CIPS) panel unit root tests for stationary. Second, we use Dumitrescu–Hurlin panel causality tests for the causality approach. Finally, we used the ARDL panel and the panel VAR approaches to estimate the Dynamic linkages between the studied variables.

The results obtained from the ARDL Panel model in the short term indicate no relationship between the independent variables of the study (ECI, EFI, MII) and the dependent variable (GDPg). This result is consistent with the results derived from the Impulse Response Fonction (IFRS), which indicates that (GDPg) is not affected by the shocks that occur in (ECI, EFI, MII). Also, this result means that changes related to economic Complexity, Economic Freedom, and economic stability are taking place slowly.

This study also applies the second-generation cross-sectional augmented Dickey-Fuller, cross-sectional Im, Pesaran, Shin panel (CIPS) unit root test, and the latest (Westerlund 2007) cointegration tests. In addition, the direction of short-run and long-run causal relationships was also investigated using the PVAR model. Analyzing the results that were reached through the panel Granger causal test (Dumitrescu Hurlin, 2012) and the impulse response functions (in the PVAR approach) confirmed the existence of a reciprocal influence relationship on the one hand. On the other hand, there is a reciprocal response to shocks between economic Freedom and economic Complexity and between economic Complexity and macroeconomic stability, finally achieving economic growth.

Thus, policymakers should design economic growth policies that complement measures of Economic Freedom with more macroeconomic stability and accumulated economic Complexity to enhance economic growth in North African countries. Our results indicate that the positive impact of Economic Freedom on economic growth is magnified when a country's economic Complexity and macroeconomic stability and expressing their political Freedom, political stability, and economic Complexity.

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