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## Economic Complexity and Human Development in MENA Countries: A Panel ARDL Analysis

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### *Abstract*

Economic complexity has become a hot new topic in recent decades. Economic complexity reflects the amount of know-how embedded in an economy's productive structure. The primary purpose of this research is to comprehend the relationship between economic complexity and human development in 13 Middle East and North Africa (MENA) countries from 1998 to 2021. Using a Panel Autoregressive Distributed Lag Model (ARDL) model, the econometric results proved that there is a stable statistically significant long-run relationship between Economic Complexity and Human Development. More economic complexity generates greater standard of living which, engenders more education, better health care and better social services.

*JEL:*F14, O15, R15.

**Keywords:** *Economic Complexity, Human Development, Panel ARDL, MENA countries.*

### Introduction

Economic complexity has become a hot new topic in recent decades. Economic complexity reflects the amount of knowhow that is embedded in the productive structure of an economy. Few studies have analyzed the relationship between economic complexity and human development. This approach is an interesting subject for a country's development policy.

The theoretical arguments point out both positive and negative effects, but lack empirical support. In this paper, we attempt to address these arguments by examining the impact of economic complexity on human development in MENA countries.

Hartmann D. (2014) shows that there are plenty of reasons why complexity has positive effects on human development. More economic complexity generates greater standard of living which, in turn, engenders more education, better health care and social services.

the rest of the paper is organized as follows: In the next section we define economic complexity and its measures. In section 2 we discuss the relationship between economic complexity and human development. In section 3, the study introduces the data, the model specification and the PMG estimator proposed by Pesaran & al. (2001). The results and discussion are presented in Section 4. Finally, in Section 5 we present the conclusion and recommendations.

### 1- Economic complexity

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The theory of economic complexity is based on the realization that the development of products and services not only requires raw materials, labor, and machinery, but also tacit knowledge (“knowhow” or “productive capabilities”) of how inputs are combined to produce outputs and run business operations (Hausmann, Hidalgo and al. 2011). This tacit knowledge tends to be the limiting factor for diversifying economic activities because it is the most difficult component of production to transfer. Whereas many other inputs to production—including materials, tools, and blueprints—are relatively easy to trade and transfer, tacit knowledge can only be acquired through experience (Hausmann R. & al. 2023).

Complexity arises through the type of goods produced, which defines a country’s productive structure (Hausmann R. & al. 2014). Countries available to produce high-technology goods, are more complex than commodities countries producing. Countries must overcome dependence on commodities because this causes negative or unstable terms of trade, macroeconomic volatility, Dutch disease phenomenon, and political instability (Nkurunziza & al. 2017).

During the past decade the principal accelerator of the study of economic complexity was the development of metrics of complexity. Complexity metrics were originally discovered using international trade data and validated by their ability to predict future economic growth (Hausmann R. & C.A. Hidalgo (2009), Hausmann R. & al. 2014).

More recently, many authors have begun using economic complexity to explore additional implications of economic structures, such as geographic differences in income inequality (Hartmann & al. 2017), human development (Ferraz, D. 2018, Lapatinas A. 2016) and greenhouse gas emissions (Romero, J. P. & Gramkow, C. 2021).

Today, economic complexity indicators are published regularly in online tools, such as the Observatory of Economic Complexity, or official government websites, such as Data México from Mexico’s Secretary of the Economy. In this paper we use Economic Complexity Index evaluated by the Observatory of Economic Complexity. In this database The Economic Complexity Index, or ECI, is a measure of an economy’s capacity which can be inferred from data connecting locations to the activities that are present in them. ECI has also been estimated using diverse data sources, such as trade data, employment data, stock market data, and patent data.

The complexity of a country that is given by its diversity, by also looking at the ubiquity of the products that it makes. Diversity is related to the number of products that a country exports. This is equal to the number of links that this country has in the network that relates countries to the products that they export. Ubiquity is related to the number of countries that export a product. This is equal to the number of links that this product has in this network

ECI is an index developed by Hausmann and Hidalgo to indicate the productive structure of an economy. This index represents information about the diversity of an economy’s comparative advantage and the uniqueness of a given product (Hidalgo and Hausmann, 2009). A high ECI indicates that the economy is diverse and sophisticated, and exports products with low ubiquity.

Ranking	Country	ECI 2001	Country	ECI 2011	Country	ECI 2021
1	Japan	1.917052	Japan	2.231291	Japan	2.061968
2	Germany	1.831888	Switzerland	1.94484	Switzerland	1.939998
3	Switzerland	1.816733	Germany	1.89964	Chinese Taipei	1.928829
4	Sweden	1.785835	Chinese Taipei	1.729294	South Korea	1.824754
5	United Kingdom	1.743537	Sweden	1.702193	Germany	1.807232
6	United States	1.701259	Czechia	1.621018	Singapore	1.73669
7	Finland	1.656022	United States	1.619526	Czechia	1.564133
8	Ireland	1.535051	Finland	1.611438	Sweden	1.535557
9	Austria	1.522086	Singapore	1.606571	Austria	1.497664
10	France	1.440872	South Korea	1.591962	United States	1.463427

Table 1: Economic Complexity Index Top10 Country Ranking

source: Observatory of Economic Complexity <https://oec.world/en/resources>

As Table 1 shows that, Japan continue to be the most complex country. Since 2011 Switzerland is in the second rank. The complexity country rankings differ substantially for the other countries. Chinese Taipei and South Korea, has known good evolution and ranked respectively third and fourth in 2021. The high complexity in Chinese Taipei and South Korea is driven by a high share of value-added exports in complex manufacturing industries such as electronics. We note also that countries like France, United Kingdom are not present among the top 10 in economic complexity in 2021.

In MENA countries (Table 2), we note that Economic complexity index (ECI) is low and even negative for some countries. The most complex economies in 2021 were Saudi Arabia, Turkey and Kuwait. However, Algeria and Libya have respectively the lowest economic complexity index.

Ranking	Country	ECI 2001	Country	ECI2011	Country	ECI2021
1	Jordan	0.272937	Saudi Arabia	0.509374	Saudi Arabia	0.899811
2	Saudi Arabia	0.212627	Turkey	0.338102	Turkey	0.607041
3	Turkey	0.014827	Kuwait	0.142548	Kuwait	0.342244

4	Kuwait	- 0.3381 9	Qatar	0.068 516	Tunisia	0.218 691
5	Iran	- 0.3777 7	United Arab Emirates	0.006 76	United Arab Emirates	0.161 374
6	Tunisia	- 0.4005 4	Jordan	- 0.007 93	Jordan	0.027 08
7	Oman	- 0.5263 6	Tunisia	- 0.062 42	Iran	- 0.090 55
8	United Arab Emirates	- 0.5453 5	Libya	- 0.120 7	Egypt	- 0.098 91
9	Egypt	- 0.5565 1	Iran	- 0.170 43	Qatar	- 0.173 45
10	Algeria	- 0.8040 6	Egypt	- 0.337 86	Oman	- 0.197 63
11	Libya	- 0.8191 2	Oman	- 0.528 8	Morocco	- 0.282 12
12	Morocco	- 0.8307 6	Morocco	- 0.690 37	Algeria	- 0.877 72
13	Qatar	- 0.9381 3	Algeria	- 0.731 44	Libya	- 1.180 02

Table 2: Economic Complexity Index for MENA Region

Source: Observatory of Economic Complexity <https://oec.world/en/resources>

### **Economic Complexity and Human Development:**

According to Hidalgo & Hausmann (2009), factors such as capital, land and labor are not enough to produce goods. Countries also need to have adequate infrastructure, property rights, regulations, labor skills and skilled labor. High-technology goods producer's countries (medical equipment, software and others) need more advanced knowledge than commodities producer's countries. Hausmann & al., (2014) argue that knowledge is also a relevant production factor, since goods are vehicles of knowledge and that complex economies are those knowledge producers through a network of people, creating a wide variety of knowledge-intensive products.

On the other hand, low complexity economies are those with a narrow base of productive knowledge and produce a smaller variety of goods, which require less knowledge and less people integration.

Recent studies have argued that economic complexity has been connected to human

development. The theoretical arguments point out both positive and negative impact of economic complexity on countries human development.

Ferraz, D. al. (2018), Le Caous, E.; Huarng, F.(2021) and others proved the positive correlation and statistical significance between Economic Complexity and Human Development. Hartmann D. (2014) shows that there are plenty of reasons why complexity has positive effects on human development. More economic complexity or sophistication generates greater standard of living which, in turn, engenders more education, better health care, social services, water, electricity etc. Increased economic complexity may include the production of medicines, health related equipment, and medical training, all of which improve the well-being of the country's people (Lapatinas A. (2016).

For Hartmann D. & al. (2017), even though Latin American economies showed social improvements, there was no economic diversification, which reflected in the lack of better quality jobs. On the other hand, Asian countries have invested in human capital and technological innovation have made their economies more robust and complex (Lee J.W.(2016)).

For Ferrarini B. and P. Scaramozzino (2016), economic complexity influences the development of new skills and the formation of human capital. Complex economic systems require a set of capabilities adaptable to technological change. To grow and modernize, the state must provide conditions for the intensification of innovation, competitiveness and economic diversification.

Arica F. & U. Kurt (2021) investigates the impact of the Human Development Index (HDI) on economic complexity index (ECI) in selected 24 OECD countries. Using panel data methodology for the period 1995-2018, the results of the study show that there has been a unidirectional causality running from economic complexity to human development in five developed countries, but human development Granger cause economic complexity in six countries.

On the other hand, there are also negative effects of economic complexity on human development and well-being of people. These negative effects vary from ecological unsustainability, when the increased demand for products leads to more consumption, production and resource exploitation, to dissatisfaction due to the increased complexity and uncertainty of decision processes (Schwartz (2004)).

Lapatinas A. (2016) argue that, although economic complexity and social development are positively correlated, there is no evidence of a causal effect. The author shows that economic complexity is not a determinant of human development. This finding might be attributed to the following: the positive effects that economic complexity has on economic agent's freedom of social choices are possibly canceled out by negative effects (Sen A. 2001), indicating that economic complexity alone does not necessarily tug human's well-being. Furthermore, economic complexity is not a 'basic human need', such as education, happiness and health, hence it is not a core explanatory variable of human development.

## **Data and Methodology**

### **Data Analysis**

The study uses annual data from 1998 to 2021 for 13 MENA economies. The selection of the period and the set of countries is based on the availability of data. The data was obtained from the Observatory of Economic Complexity (OEC) and UNDP (United Nations Development Programme) Human Development Reports.

<b>Abbreviation</b>	<b>Variable</b>	<b>Source</b>
<i>ECI</i>	Economic complexity index	Observatory of Economic Complexity
<i>LE</i>	Life Expectancy at Birth	Human Development Report 2021/2022 UNDP
<i>MYS</i>	Mean Years of Schooling	Human Development Report 2021/2022 UNDP
<i>EYS</i>	Expected Years of Schooling	Human Development Report 2021/2022 UNDP
<i>GNIPC</i>	Gross National Income Per Capita	Human Development Report 2021/2022 UNDP

Table 3: Definition of Variables and Data Sources

Economic complexity index (ECI) (the dependent variable) is a measure of the relative knowledge intensity of an economy.

The other variables summarize key dimensions of human development: a long and healthy life, being knowledgeable and having a decent standard of living.

The health dimension is assessed by life expectancy at birth, the education dimension is measured by mean of years of schooling for adults aged 25 years and more and expected years of schooling for children of school entering age. The standard of living dimension is measured by gross national income per capita. Table 4 provides the descriptive statistics of the variables employed in the study.

	<i>ECI</i>	<i>EYS</i>	<i>LE</i>	<i>MYS</i>	<i>GNIPC</i>
<b>Mean</b>	-0.287180	13.11783	74.26263	7.779541	31235.25
<b>Median</b>	-0.214923	12.96369	74.45145	7.583369	14330.85
<b>Maximum</b>	0.899811	18.33822	80.98970	12.69403	104640.3
<b>Minimum</b>	-1.902488	7.678890	66.01760	3.020000	4261.310
<b>Std. Dev.</b>	0.500319	1.759115	3.126901	1.885938	28550.90
<b>Skewness</b>	-0.214490	0.207594	-0.186642	0.033258	1.059477
<b>Kurtosis</b>	2.845842	3.414469	2.534091	2.793072	2.744061
<b>Jarque-Bera</b>	2.683933	4.445468	4.603663	0.610229	58.84154
<b>Probability</b>	0.261331	0.108313	0.100075	0.737039	0.000000
<b>Sum</b>	-89.02565	4066.528	23021.41	2411.658	9682927.
<b>Sum Sq. Dev.</b>	77.34875	956.1956	3021.251	1099.040	2.52E+11
<b>Observations</b>	310	310	310	310	310

Table 4: Summary Statistics

### Panel Unit root Test

The initial step in this empirical approach is to identify the order of integration in the data. This is important since in order to estimate an ARDL model it needs to be ensured that the variables

in the regression are either integrated of order zero  $I(0)$  or integrated at order one  $I(1)$ . This is because in the presence of integrated of order two  $I(2)$  variables the ARDL bounds testing approach fails to provide robust results.

in order to determine the order of integration and test for unit root in the group of panel series in our dataset, we use the Im, Pesaran, Shin (2003) (IPS) and Levin, Lin, Chu (2002) (LLC) tests. The LLC test functions by assuming a common unit root process, while the IPS test assumes an individual unit root process. Table 5 reports the results of stationarity tests. The results show that the order of integration of the variable ECI is  $I(0)$ , however the variable EYS, MYS, LE and LGNIPC are  $I(1)$ . Due to the existence of mixed levels of integration among series we proceed to apply the Panel ARDL approach rather than traditional static or panel cointegration test (Asteriou D. and V. Monastiriotis 2004).

ARDL model distinguishes between short and long-run coefficients and can be reliably used on short sample periods. In fact, Pesaran M.H. and Y. Shin (1998) show that even if the sample size is small, the long-run parameters are super-consistent while the short run parameters are consistent.

<i>Variables</i>	<i>LLC Test</i>	<i>IPS Test</i>	<i>LLC Test</i>	<i>IPS Test</i>	<i>Order of integration</i>
	<i>Level</i>		<i>1<sup>st</sup> difference</i>		
<i>ECI</i> ( <i>P-value</i> )	-4.51805* (0.0000)	-4.44302* (0.0000)	-9.31866* (0.0000)	-9.07910* (0.0000)	$I(0)$
<i>EYS</i> ( <i>P-value</i> )	-0.32859 (0.3712)	0.14539 (0.5578)	-3.72575* (0.0001)	-2.85479* (0.0022)	$I(1)$
<i>MYS</i> ( <i>P-value</i> )	-0.54105 0.2942	0.31461 (0.6235)	-3.51355* (0.0002)	-5.42170* (0.0000)	$I(1)$
<i>LE</i> ( <i>P-value</i> )	9.68317 (1.0000)	5.50809 (1.0000)	-3.32578* (0.0004)	-4.17836* (0.0000)	$I(1)$
<i>LGNIPC</i> ( <i>P-value</i> )	-0.71236 (0.2381)	1.32735 (0.9078)	-8.22413* (0.0000)	-9.83966* (0.0000)	$I(1)$

Table 5: Unit root Test

\* indicates the statistical significance at 1%.

### Panel ARDL Estimation

To estimate the panel ARDL regression the pooled mean group (PMG) technique is used. This estimation technique combines both averaging and pooling of coefficients (Pesaran, Shin and Smith 1997, 1999). This panel method allows the intercepts, short-run coefficients and error variances to differ freely across groups. Meanwhile, the likelihood-based PMG estimator constrains the long-run coefficients to be identical across groups (Juergen A. 2019). The suitable lag length is selected based on the AIC lag selection criteria. The results of the estimation are presented in table 6.

The results show that in long run, all the variables are statically significant. Except the variable EYS all coefficients of the explanatory variables are in line with expectations of economic theory. Mean years of schooling (MYS), Life Expectancy at Birth and Gross National Income Per Capita (LGNIPC) affect positively economic complexity (ECI). So in long run we found a positive relationship between economic complexity and different forms of human development.

Education, Health and Income have a positive impact on economic complexity.

<i>Dependent Variable: D(ECI)</i>				
<i>Method: ARDL</i>				
<i>Sample: 1999 2021</i>				
<i>Included observations: 297</i>				
<i>Maximum dependent lags: 2 (Automatic selection)</i>				
<i>Model selection method: Akaike info criterion (AIC)</i>				
<i>Dynamic regressors (2 lags, automatic): EYS MYS LE LGNIPC</i>				
<i>Fixed regressors:</i>				
<i>Number of models evaluated: 4</i>				
<i>Selected Model: ARDL(1, 1, 1, 1, 1)</i>				
<i>Variable</i>	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-Statistic</i>	<i>Prob.</i>
<i>Long run equation</i>				
<i>EYS</i>	0.120795	0.030835	3.917458	0.0001
<i>MYS</i>	0.123759	0.028364	4.363296	0.0000
<i>LE</i>	-0.050456	0.013290	-3.796512	0.0002
<i>LGNIPC</i>	0.122709	0.085512	1.434993	0.1526
<i>Short run equation</i>				
<i>COINTEQ01</i>	-0.179740	0.059989	-3.000774	0.0030
<i>D(EYS)</i>	-0.002976	0.019692	-0.151130	0.8800
<i>D(MYS)</i>	-0.072798	0.090800	-0.801747	0.4235
<i>D(LE)</i>	0.037340	0.024250	1.539811	0.1249
<i>D(LGNIPC)</i>	0.018366	0.166993	-0.109982	0.9125
<i>Mean dependent var 0.027149</i>			<i>S.D. dependent var 0.134258</i>	
<i>S.E. of regression 0.127843</i>			<i>Akaike info criterion -1.695940</i>	
<i>Sum squared resid 3.938861</i>			<i>Schwarz criterion -0.864251</i>	
<i>Log likelihood 331.8706</i>			<i>Hannan-Quinn criter. -1.363466</i>	

Table 6: Panel ARDL Estimation of 13 MENA Countries

Source: Authors' calculation

Concerning the short run result in Table 6, we found that all the variables are not having significant relationships. The error correction coefficient COINTEQ01 represents the speed of adjustment to restore equilibrium in the dynamic model following a disturbance. This coefficient in the full panel ARDL regression is -0.179. This significant and negative error correction term (COINTEQ01) coefficient also supports evidence that there is a stable long-run relationship between the dependent variable and the regressors.

## Conclusion and Recommendations

The primary purpose of this research is to comprehend the relationship between economic complexity and human development. This paper attempted to bridge a gap between theory and empirics on the effects of different key dimensions of human development on economic complexity. Using a Panel ARDL model, the econometric results proved the positive correlation and statistical significance between Economic Complexity and Human Development. The results show that economic complexity and human development are positively correlated. More

economic complexity generates greater standard of living which, engenders more education, better health care and better social services.

Thus, in this paper we use economic complexity index(ECI) as a measure of economic complexity. However, future studies need to introduce new indicators of economic complexity, such as product complexity index, the Complexity Outlook Index...

For human development, future studies may include variables that demonstrate income and gender inequality and the democratic participation of citizens.

The results show also, that the relationship between economic complexity and human development can be influenced by other factors like international migration and logistics performance.

Finally, we note that MENA countries can support their development strategy by more diversification and more complexity of their economies.

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