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How to improve agricultural value-added in the MENA region? Implementation of Diamond Porter's theory in agriculture

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The global economy in recent decades has experienced frequent shocks. Many regions must improve their competitiveness and value-added to deal with this. One of them is in the Middle East and North Africa (MENA), where a rise in agricultural value-added (AVA) can produce more jobs than in other sectors. It is necessary to consider increasing AVA in the MENA region. Hence, the aim of this study is identifying the determinant factors of AVA in the MENA region. We employed 13 countries in the MENA region as samples in this study. The study's data spans 45 years, from 1975 to 2019. Static panel data regression analysis was employed in this study. AVA can growth by increasing the irrigated land, credit, and human capital. Meanwhile, growing inflation and economic globalization will reduce AVA. Therefore, we recommend that countries in the MENA region have to increase irrigation infrastructure, expand agricultural credit availability, encourage farmers to get a good education, improve research and development, control inflation, and find the best way to implement economic globalization.

KEYWORDS

irrigated land, credit, human capital index, inflation, economic globalization

Introduction

The global economy in recent decades has experienced frequent shocks (Espitia et al., 2022). Unemployment rates rose, banks and financial crises were widespread, and international trade dropped faster than global incomes during the shocks (Grossman and Meissner, 2010). Several important cases have an impact on global economic shocks, such as trade wars (Sterne, 2019), the COVID-19 pandemic (Yilmazkuday, 2022), wars between countries (Tosun and Eshraghi, 2022) and others.

The global economic shock is a challenge for all countries since its impact is highly disruptive to a country's or region's economy. For example, global trade fell by almost 13% in the first half of 2020 because of the COVID-19 pandemic. Moreover, the mobility and trade growth dropped when most countries implemented lockdown rules in the first 3 months of the pandemic (February–April 2020) (Espitia et al., 2022). In developing countries, the pandemic also threatens food security and human welfare (Joshi et al., 2022; Rahimi et al., 2022). Meanwhile, the confrontation between Russia and Ukraine puts excessive pressure on global trade and equities markets (Mostenska et al., 2022; Tosun and Eshraghi, 2022). Several countries responded by competing to improve their efficiency (Escoto et al., 2022), competitiveness (Rahimi et al., 2022), and market share (Díez et al., 2021) of superior sector products.

Strengthening competitiveness is one of the most well-known and discussed topics nowadays. Classical economists stated that the country's competitiveness can be improved by encouraging natural resources, labor productivity, interest rates, and exchange rates. According to the latest paradigm, a country will gain competitiveness if it can innovate and upgrade knowledge and technology. Economic globalization can also be a way to accelerate competitiveness due to tight pressures and challenges faced by a country and its economic actors. They benefit from intense competition with rivals and variations in consumer demand (Porter, 1990).

Michael Porter, a modern economist, said that the competitiveness of a country is influenced by factor conditions, demand conditions, related and supporting industries, and firm strategy, structure, and rivalry. Factor conditions include a country's skilled labor resources and infrastructure to face global competition. Demand conditions describe home-market demand for products and services. Related and supporting industries are needed by suppliers and other related industries to win the competition at the international level. Lastly, how does the government create, organize, and manage its economy. All of this came to be known as "Diamond Porter" (Porter, 1990). Prasada et al. (2022) studies have shown that this theory is very suitable for developing the competitiveness and value-added of a product.

In our opinion, Porter's theory is very suitable for many sectors, including agriculture. This sector plays a vital role in supplying food, employment, and foreign exchange for a country (Melo and Foster, 2021). On the other hand, agriculture is a "poverty pocket" in many countries (Sánchez et al., 2022). Moreover, most agricultural players have a poor level of education, making technological innovations challenging to implement (Aminu et al., 2022). This situation disrupts the efforts to achieve the Sustainable Development Goals, which aim to eliminate global poverty and hunger.

Another challenge in the agricultural sector is climate change (Oldekop et al., 2020). The average global surface temperature in the last 30 years has risen by 0.2°C per decade (Hansen et al., 2006), while precipitation has fallen (Trenberth, 2011). As a result, global food production, agricultural employment and producer's net income have decreased (Melo and Foster, 2021). Meanwhile, farmers are having trouble getting water for their farmland and have begun to restrict the number of planting times (Chiarelli et al., 2022). This is a particularly troubling problem in countries where water has long been scarce, such as the Middle East and North Africa (MENA). In fact, MENA plays a vital role in supplying food to European, Asian, and American countries (Freund and Braga, 2012). On the other hand, Arab countries are also the highest net importers of grains in the world (Keulertz and Woertz, 2015).

The agri-food sector contributes a small but significant amount to countries' economies in the MENA region, particularly those that have already undergone a structural transformation. Agricultural production can stimulate growth in the broader economy, especially input production, food processing, logistics, and financial services. Agriculture contributes significantly to job creation and net trade, such as Saudi Arabia and Jordan (Bahn et al., 2021; Abou Zaki et al., 2022). Anik et al. (2020) stated that the MENA has one of the highest total factor productivity levels in the world, allowing for significant increases in agricultural production through technological advancements (research and development) and infrastructural investments (irrigation, roads, and electricity). However, food insecurity is still widespread in the MENA region. Around 9.0% of the area population was undernourished in 2017–2019, with 30.2% of the population experiencing moderate or severe food insecurity (Bahn et al., 2021; Abou Zaki et al., 2022).

Based on the previous explanation, the objective of this study is to identify the determinant factors of agricultural value-added (AVA) in the MENA region. This research is critical because every percentage of growth in AVA contributes to employment growth by 0.36% (vs. industry at 0.30% and service at 0.20%) in the MENA region (Bahn et al., 2021). We also want to show that Porter's theory is applicable to the agricultural sector, as it has been used to develop company competitiveness in the past. The most essential and novelty aspect of this research is that it is the first comprehensive study of how to boost AVA in the MENA region. Previous studies have focused on the linkage between AVA with different types of energy usage (Zamani, 2007), CO_2 emissions (Mehdi and Slim, 2017; Omri and Saidi, 2022), and trade (Ben Jebli and Ben Youssef, 2017).

Literature review and hypothesis

The land is increasingly being managed to meet a variety of societal needs. The land is currently being used to address needs for food, fiber, habitation, carbon sequestration, water purification, biodiversity protection, and recreation (Ellis et al., 2019). The land also has a vital role in increasing AVA. Ben Jebli and Ben Youssef (2019) stated agricultural land (LAND) and AVA have both short and long-term causality. This is because an increase in LAND will increase production, allowing AVA to rise even higher. This is supported by Sinha (2019), who claims that arable land and permanent cropland can have a long-term beneficial and consistent impact on AVA growth. In Italy, AVA will be lost by 5–7% in the area that vulnerable to land degradation (Salvati and Carlucci, 2010).

Hypothesis 1: Agricultural land will increase AVA in the MENA region.

In many countries, expanding irrigation is one of the strategy to increase food production (Chiarelli et al., 2022). The irrigation program is vital for stimulating AVA growth (Buisson and Balasubramanya, 2019). Mosavi et al. (2020) also showed that irrigated land could generate better AVA for food crops, fruits, and vegetables than unirrigated land. The number of hectares equipped for irrigation appears to be decreasing AVA in the short term but this negative response can be reversed in the long term (Sinha, 2019).

Hypothesis 2: Land area equipped for irrigation will increase AVA in the MENA region.

An increase in fertilizer will boost production and AVA (McArthur and McCord, 2017). In addition, the AVA will get higher if fertilizer use is efficient (Orsini et al., 2013; Rahut et al., 2021). However, Sinha (2019) stated that chemical fertilizer use appears to be adversely correlated with AVA growth. This is generally due to price fluctuations in chemical fertilizers, which result in higher production costs. Furthermore, the long-term use of chemical fertilizers reduces soil fertility and productivity (Sassi and Abera Mamo, 2019).

Hypothesis 3: Nutrient nitrogen (N) will increase AVA in the MENA region.

The agri-food sector in the MENA contributes to climate change through greenhouse gas emissions (Bahn et al., 2021; Rahut et al., 2021). As a result, a temperature rise is responsible for reducing AVA in the MENA (Mosavi et al., 2020). Jemmali et al. (2021) stated that AVA will be reduced when temperatures rise and rainfall decrease. Likewise, CO_2 emissions and fuel consumption also harm AVA (Qureshi et al., 2016). The causality relationship also occurs where an increase in AVA will stimulate growth in carbon emissions and temperatures in the MENA region (Ismael et al., 2018).

Hypothesis 4: Temperature change will decrease AVA in the MENA region.

According to Nugroho et al. (2021), a rise in product prices will fall in AVA. Input price increases will drive up production costs, creating an adverse situation for AVA. Meanwhile, rising output prices will reduce product competitiveness.

Hypothesis 5: Inflation will decrease AVA in the MENA region.

The growth of AVA responds positively to agricultural credit. A 1% rise in farm credit results in a 0.17% increase in overall AVA (Koç et al., 2019). Sarma and Pais (2008) stated that bank credit not only increases AVA but also supports growth in GDP. Furthermore, credit and other forms of funding like agricultural investment have been shown to help AVA expand (Leimane et al., 2017).

Hypothesis 6: Domestic agricultural credit will increase AVA in the MENA region.

AVA is influenced positively by two primary factors from the economic globalization index (EGI), namely foreign direct investment (FDI) inflow and agricultural exports. In other words, a rise in FDI inflow and agricultural exports will cause an increase in AVA (Nugroho et al., 2021). Sebri and Abid (2012) stated that trade openness influences the creation of AVA. Nonetheless, Effiom and Ebi (2020) findings demonstrate that trade openness is a deterrent for AVA. This is because trade openness was implemented when domestic production capacity was low.

Hypothesis 7: Economic globalization will increase AVA in the MENA region.

Improved educational opportunities in rural areas will boost AVA (Ogbeide-Osaretin and Ebhote, 2020; Rahut et al., 2021). In addition, education is a valuable asset for young people and is required to take advantage of various opportunities, including AVA (Vasa, 2002; Heckert et al., 2021). As a result, Nugroho et al. (2021) argued for the role of education in the development of AVA.

Hypothesis 8: Human capital will increase AVA in the MENA region.

Methods

Data source

We employed 13 countries in the MENA region as research samples in this study, including Algeria, Bahrain, Egypt, Iran, Iraq, Jordan, Kuwait, Morocco, Qatar, Saudi Arabia, Syria, Tunisia, and Turkey. The country was chosen after considering several factors, including (Keulertz and Woertz, 2015; Bahn et al., 2021): (1) the agricultural sector is the highest employer in these countries; (2) agricultural contribution as a share of total employment is higher than agriculture as a share of GDP in every country; (3) conflict and social instability have hampered the agriculture sector's performance in MENA region in recent decades; and (4) agriculture has shown to be crucial in resettling internally displaced people.

The study's data spans 45 years, from 1975 to 2019. The research includes 9 variables, including 1 dependent variable (Agricultural Value Added, which represents a country's competitiveness) and 8 independent variables (agricultural land use, land area equipped for irrigation, nutrient nitrogen *N*, temperature change, inflation, domestic agricultural credit, economic globalization index, and human capital index). These

TABLE 1 Variables and data sources of the research.

Variable	Symbol	Unit	Source	Expected sign
Dependent variable				
Agricultural value-added	AVA	Million US$	FAO	
Independent variable				
Agricultural land use	LAND	000 ha	FAO	+
Land area equipped for irrigation	IRRI	000 ha	FAO	+
Nutrient nitrogen (N)	NUT	Ton	FAO	+
Temperature change	TEMP	°C	FAO	-
Inflation	INF	%	World Bank	-
Domestic agricultural credit	CRED	% of GDP	World Bank	+
Economic globalization index	EGI	Index	KoF	+
Human capital index	HCI	Index	PWT	+

variables were collected from various data sources, as shown in Table 1.

Data analysis

Static panel data regression analysis was employed in this study because we used a combination of time-series and cross-sectional data. There are three static panel methods: pooled effect model (PEM), fixed effect model (FEM), and random effect model (REM). The PEM examines how the dependent variable and several explanatory variables maintain their consistency over time. Individual data were pooled without considering individual variation, resulting in a model with varying coefficients. The FEM allows for different intercepts for each cross-sectional unit but assumes that the slope coefficient is constant throughout them. Meanwhile, the lack of FEM to include relevant explanatory variables that do not change over time (and possibly others that do change over time but have the same values for all cross-sectional units) results in the REM (Gujarati, 2003; Wooldridge, 2020).

The determinant factors of AVA in the MENA region were estimated with the following function:

$$\mathrm{AVA} = \mathrm{f(LAND,\ IRRI,\ NUT,\ TEMP,\ INF,\ CRED,\ EGI,\ HCI)} \quad (1)$$

Based on function (1), we formulated the static panel model:

$$\mathrm{AVA} = \beta_0 + \beta_1\mathrm{LAND} + \beta_2\mathrm{IRRI} + \beta_3\mathrm{NUT} + \beta_4\mathrm{TEMP} + \beta_5\mathrm{INF} + \beta_6\mathrm{CRED} + \beta_7\mathrm{EGI} + \beta_8\mathrm{HCI} + \mathrm{e} \quad (2)$$

Three tests were used to evaluate the panel data analysis model: the Chow, Hausman, and Lagrange multiplier (LM) tests (Gujarati, 2003). The Chow test can be used to see if two groups have different multiple regression functions. Gregory Chow introduced this test, which is the F-test for the equivalence of two regressions. The Chow test is used to examine a difference in the intercept indicator (θ) and interaction of each variable. If no differences exist, the data can be pooled into a single sample without measuring slopes or intercepts for differing accounts (Wooldridge, 2020).

The hypothesis of the Chow test is as follows:

H_0: $\theta_1 = \ldots = \theta_n = 0$, pooled effect model,
H_1: $\theta_1 \neq \ldots = \theta_n \neq 0$, fixed effect model.

The test statistic for the hypotheses is:

$$\mathbf{F} = \frac{(\mathrm{SSE_R} - \mathrm{SSE_U})/\mathrm{J}}{\mathrm{SSE_U}/(\mathrm{N}-\mathrm{K})} \quad (3)$$

where SSE_R is the sum of squares residuals of the restricted model, SSE_U is the sum of squares residuals of the unrestricted model, J is the number of restrictions, N is the number of observations, and K is the number of coefficients in the unrestricted model.

Hausman tests function to check for a correlation between the explanatory variable and the error term (ρ). The hypothesis of this test is as follows:

H_0: $\rho = 0$, random effect model,
H_1: $\rho \neq 0$, fixed effect model.

The Hausman test can be conducted with specific coefficients, using a t-test, or jointly, using an F-test or a Chi-square test. The test statistic for the hypotheses is (Wooldridge, 2020):

$$\mathbf{t} = \frac{\mathrm{b_{FE,k}} - \mathrm{b_{RE,\,k}}}{\left[\mathrm{var}\left(\mathrm{b_{FE,\,k}}\right) - \mathrm{var}(\mathrm{b_{RE,\,k}})\right]^{1/2}} = \frac{\mathrm{b_{FE,k}} - \mathrm{b_{RE,k}}}{\left[\mathrm{se}(\mathrm{b_{FE,k}})^2 - (\mathrm{b_{RE,k}})^2\right]^{1/2}} \quad (4)$$

where β_k is the parameter of interest, $b_{FE,\,k}$ is the fixed effects estimate, and $b_{RE,k}$ is the random effects estimate.

The LM test, or Breusch–Pagan test for heteroskedasticity is based on a variance function (β). The general form for this function is (Hill et al., 2011):

$$\mathrm{var}(\mathrm{y_{it}}) = \sigma_\mu^2 = \mathrm{E}\left(\mu_{\mathrm{it}}^2\right) = \mathrm{h}(\beta_0 + \beta_1\mathrm{X_{1it}} + \ldots + \beta_8\mathrm{X_{8it}}) \quad (5)$$

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TABLE 2 Descriptive statistics.

Country	AVA		LAND		IRRI		NUT		TEMP		INF		CRED		EGI		HCI	
	Average	Std dev	Average	Std dev	Average	Std dev	Average	Std dev	Average	Std dev	Average	Std dev	Average	Std dev	Average	Std dev	Average	Std dev
Algeria	8,533.58	6,207.80	40,640.49	1,600.29	682.32	386.45	55,538.40	23,008.73	0.86	0.63	9.18	7.79	30.00	23.26	36.36	5.40	1.74	0.36
Bahrain	55.68	26.85	8.74	0.62	2.87	1.42	836.36	807.45	0.74	0.82	3.11	5.32	49.11	13.70	76.04	5.41	2.10	0.25
Egypt	13,593.59	10,828.84	3,137.40	497.98	3,128.29	493.10	925,175.18	280,415.08	0.37	0.66	11.84	5.97	32.26	11.75	50.77	6.14	1.90	0.45
Iran (Islamic Republic of)	19,907.07	14,935.39	56,787.98	7,375.39	7,653.62	1,415.60	668,205.93	273,539.08	0.76	0.69	19.17	9.09	33.05	15.98	24.65	6.28	1.70	0.41
Iraq	3,492.02	2,877.72	9,100.61	434.48	2,957.44	819.78	152,137.51	99,674.50	0.62	0.82	36.80	92.14	6.25	1.83	45.75	4.31	1.76	0.38
Jordan	640.78	605.66	1,068.05	51.67	71.93	23.10	10,349.18	6,554.71	0.43	0.79	5.45	5.26	64.39	14.45	62.33	10.38	2.25	0.51
Kuwait	248.11	221.79	144.21	6.47	7.29	6.08	1,064.11	830.87	0.73	0.82	3.76	2.98	58.06	23.94	66.50	4.37	2.01	0.19
Morocco	7,190.88	4,179.09	29,874.43	1,009.47	1,396.82	225.95	173,346.53	68,088.23	0.99	0.63	4.40	3.68	89.93	1.64	47.68	6.88	1.49	0.25
Qatar	110.10	89.95	62.57	4.93	10.93	6.27	18,661.80	115,987.38	0.73	0.76	3.78	3.83	38.86	19.41	68.62	6.20	2.24	0.44
Saudi Arabia	9,110.44	5,266.00	140,488.23	36,164.77	1,360.84	434.07	169,371.38	78,801.32	0.58	0.77	2.98	7.13	26.23	15.10	65.01	3.29	2.16	0.34
Syrian Arab Republic	4,745.38	2,809.54	13,867.73	157.14	1,018.29	341.73	144,951.48	83,653.82	0.56	0.79	15.64	14.45	11.76	5.78	39.52	8.37	2.01	0.38
Tunisia	2,418.64	1,184.13	9,372.29	451.37	369.54	86.70	55,641.29	19,923.31	0.90	0.68	5.62	2.37	63.74	9.76	53.76	4.40	1.83	0.43
Turkey	33,822.28	17,797.64	39,100.67	1,117.77	4,237.29	1,007.75	1,197,667.00	306,399.88	0.49	0.79	39.55	29.17	39.55	12.09	46.89	9.33	1.93	0.32

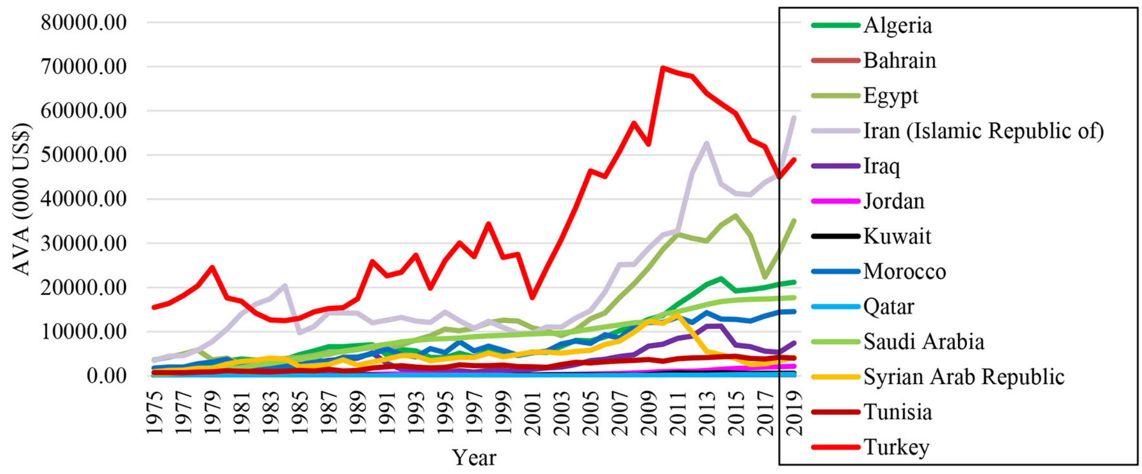

FIGURE 1
AVA in the MENA region.

The null and alternative hypotheses for the heteroskedasticity test based on the variance function are:

$H_0: \beta_1 = \beta_n = 0$, pooled effect model,
$H_1: \beta_1 \neq \beta_n \neq 0$, random effect model.

The test statistic for the hypotheses is the sample size multiplied by R^2, and has a Chi-square (X^2) distribution with S – 1 degree of freedom.

$$X^2 = N \,.\, R^2 \sim X^2_{(S-1)} \quad (6)$$

As a result of the three tests, the type of static data panel employed in this study can be decided on.

Results

The country with the highest average AVA in the MENA region is Turkey (Table 2). This can also be seen in Figure 1 where the trend of AVA Turkey increased from 1975 to 2019. Furthermore, Turkey employs the highest average NUT and experiences the highest average INF. During the same time period, Morocco had the highest average TEMP and CRED. The average values of LAND, IRRI, EGI, and HCI are in Saudi Arabia, Iran, Bahrain, and Jordan, respectively.

The best model for this study will be determined using six tests. The Chow test identifies whether this study uses a PEM or FEM analytical model. Because the p-value of the Chow test is <0.05, rejection of Ho or FEM is the chosen model for this study. However, the Hausman test result must be used to decide whether REM or FEM is the appropriate model for this study. Turns out the result of the Hausman test is probability p-value < 0.05 or rejection of Ho, we knew FEM was the proper model for our study. We confirmed that the LM or Breusch–Pagan test is not required because it is clear that FEM is the best model in this study. We also showed that the data in this study was normally distributed (probability JB > 0.05), free of multicollinearity (relationship between independent variables <0.8), free of heteroscedasticity (probability p-value > 0.05), but inconclusive from autocorrelation (dl $<$ DW $<$ dU). All test results are presented in Table 3.

After six testing steps, we used FEM to assess the relationship between this study's dependent and independent variables. Table 4 shows the findings of this study. The coefficient of land area equipped for irrigation (IRRI) has a positive and significant effect on agricultural value-added (AVA). A 1,000-ha rise in IRRI will increase AVA by 7.285 million US$ in the MENA region. The second variable that significantly impacts AVA is inflation (INF). A 1% rise in inflation will decrease AVA in the MENA region by 42.33 million US$. The coefficient of domestic agricultural credit (CRED) is positive and statistically significant at a 10% level, as seen from the estimation result. A 1% rise in CRED will increase AVA in the MENA region by 28.77 million US$. Regarding the economic globalization index (EGI) coefficient, the estimation result revealed the existence of a negative and significant association between EGI and AVA in the MENA region. AVA is reduced by 149.2 million US$ for every 1 unit rise in EGI. In contrast to EGI, the Human Capital Index (HCI) coefficient is positive and significant to AVA in the MENA region. An increase in HCI of 1-unit will increase AVA by ∼4,502 million US$. This variable also has higher elasticity to increase AVA than other independent variables. Meanwhile, three variables did not significantly impact AVA, namely agricultural land use (LAND), nutrient nitrogen N (NUT), and temperature change (TEMP).

TABLE 3 The results of Chow, Hausman, normality, multicollinearity, heteroscedasticity, and autocorrelation tests.

Type of test					Value			
Chow					285.786***			
Hausman					121.418***			
Lagrange multiplier/Breusch–Godfrey					–			
Normality (Jarque Bera)					1.703^{ns}			
Multicollinearity								
	LAND	IRRI	NUT	TEMP	INF	CRED	EGI	HCI
LAND	1	0.281	0.145	0.051	−0.007	−0.148	−0.142	0.026
IRR	0.281	1	0.732	0.075	0.244	0.214	0.571	−0.077
NUT	0.145	0.732	1	0.006	0.210	−0.093	−0.295	0.035
TEMP	0.051	0.075	0.006	1	−0.121	0.294	0.197	0.544
INF	−0.007	0.244	−0.210	−0.121	1	−0.202	−0.237	−0.130
CRED	−0.148	0.214	−0.093	0.294	−0.202	1	0.317	0.147
EGI	−0.142	0.571	−0.295	0.197	−0.237	0.317	1	0.562
HCI	0.026	−0.077	0.035	0.544	0.130	0.147	0.562	1
Heteroscedasticity								
Variable		Coef.				Std. Error		
C		1.774e+03^{ns} (1.518)				1.169e+03		
LAND		9.995e−03^{ns} (−0.860)				1.162e−02		
IRRI		7.432e−02^{ns} (0.251)				2.966e−01		
NUT		1.330e−02^{ns} (0.794)				1.680e−02		
TEMP		3.388e+02^{ns} (1.512)				2.240e+02		
INF		−6.086e+00^{ns} (−1.456)				4.179e+00		
CRED		−3.294e+00^{ns} (−0.374)				8.812e+00		
EGI		−8.282e+00^{ns} (−0.337)				2.455e+01		
HCI		2.940e+02^{ns} (0.497)				5.912e+02		
Autocorrelation (Durbin-Watson) dL = 1.470e−01 dU = 3.266e+00						2.225e−01		

Signif. codes: 0 "***" 0.001 "**" 0.01 "*" 0.05 "." 0.1 "ns" 1.
Source: Author's computation using R (2022).

Discussion

Land area equipped for irrigation (IRRI), domestic agricultural credit (CRED), and human capital index (HCI) have a significant positive effect on agricultural value-added (AVA). IRRI will increase the quantity and efficiency of agricultural production to become a stimulus for AVA growth. IRRI is very important for the MENA region which is suffering an increasing gap between freshwater supply and demand due to population, economic growth, and climate change.

There is a water source in the MENA region, which is the river. However, several issues threaten the river's water supply. Egypt, Iraq, and Syria relied on transboundary water resources such as rivers originating in different parts of the world and shared aquifers. Rivers are the primary supply of water for agriculture irrigation in Egypt and Iraq, which are endangered by upstream countries' rising water demand (Zekri and Al-Maamari, 2019). Therefore, irrigation is essential in the MENA region to sustain agricultural yield, land productivity, farmers' profit, and AVA. Irrigation is also a response to the growing worries about food and water securities, which are already strained (Nie et al., 2021).

Aside from rivers, MENA irrigation uses treated wastewater as a water source. On average, 37% of treated wastewater

TABLE 4 Fixed effect model of the impact of EG on AVA in the MENA region.

Variable	Fixed effect model	
	Coef.	Std. Error
C	−6.958e+03** (−3.256)	2.136e+03
LAND	−1.439e−02^{ns} (−0.678)	2.123e−02
IRRI	7.285+00*** (13.442)	5.420e−01
NUT	2.704e−03^{ns} (1.471)	1.818e−03
TEMP	1.503e+02^{ns} (0.367)	4.095e+02
INF	−4.233e+01*** (−5.543)	7.637e+00
CRED	2.877e+01$^{.}$ (1.785)	1.612e+01
EGI	−1.492e+02*** (−3.324)	4.486e+01
HCI	4.502e+03*** (4.167)	1.181e+03
Adj. R-Squared		0.822
F-statistic		135.988***

Signif. codes: 0 "***" 0.001 "**" 0.01 "*" 0.05 "." 0.1 "ns" 1.
Source: Author's computation using R (2022).

is reused for irrigation, with significant variations between countries. Jordan, for example, uses 90% of the treated wastewater. However, treated wastewater reuse for irrigation in MENA region is either inefficient used or the pricing system. Furthermore, the rise in operating and maintenance costs has added to the problem (Zekri and Al-Maamari, 2019). This shows that there is still potential for increasing AVA by increasing irrigation systems' quantity and efficiency.

CRED is proven to be able to increase AVA in the MENA region. This result is in line with Koç et al. (2019), who mention a 1% rise in agricultural credits in Turkey results in a 0.17% increase in AVA per hectare on average. Farmers in the MENA region will require financial assistance through credits and crop insurance (Keulertz and Woertz, 2015). CRED's affordability is crucial for long-term agricultural development. Farmers desperately use CRED to raise the quantity, quality, and technical efficiency of their products; boost their income; purchase farming inputs and machines; and facilitate the realization of technology and modernization (Bahşi and Çetin, 2020; Dawuni et al., 2021; Ganbold et al., 2021). This is projected to boost the AVA and agriculture's contribution to the MENA region's GDP.

Actually, there are many sources of agricultural CRED in the MENA region, such as state banks, private banks, credit cooperatives, relatives, and moneylenders. However, agricultural CRED capacity in MENA region is low because farmers do not have easy access to these institutions. Even if farmers can obtain credit, they must pay high loan interest rates (Bahşi and Çetin, 2020). Meanwhile, welfare and state subsidies, especially those for agriculture, have been reduced (Keulertz and Woertz, 2015). As a result, farmers will be unable to purchase agricultural inputs in optimal quantities, limiting the profitability of farming businesses (Bahşi and Çetin, 2020). In the future, smaller farmers that are struggling to make payments should be given lower interest rates and long-term loans. The provision of low-interest credits has proven to increase agricultural production, use agricultural machines and organic inputs in Nigeria (Osabohien et al., 2020), use advanced facilities to realize economies of scale and reduce agricultural storage losses in China (Zhang et al., 2022), motivate farmers to implement good agricultural practices and promote product certification in Turkey (Bulut and Celik, 2021), improve the value chain and rural entrepreneurship in Iran (Ataei et al., 2020).

CRED also needs to be given to other agricultural business actors. They will help with agriculture and infrastructure development, such as transportation to connect rural areas to urban markets, cooling chains, storage, and farmer cooperative upscaling. This can boost AVA and the agricultural supply chain (Keulertz and Woertz, 2015).

HCI is one of the important factors in the development of AVA. However, agricultural research and development institutions in the MENA region need to be significantly improved. The National Agricultural Research Center in Egypt, for example, employs almost 100,000 people, yet its extension services to help farmers are severely lacking (Keulertz and Woertz, 2015). Indeed, education is crucial for sustainable agricultural growth because it raises their knowledge, improves their skills and practices, changes their attitudes and encourages farmers to use proper strategies and technologies, such as doing postharvest operations for perishable products and boosting AVA (Ali et al., 2021; Alwedyan and Taani, 2021; Marenya et al., 2021; Zobeidi et al., 2021). In addition to farmers, food processors and retailers must be educated to provide high-value-added products. Consumer education is also necessary for them to pick high-value-added agricultural product and spend their money for buying it (Ali et al., 2021).

On the other hand, inflation (INF) and the economic globalization index (EGI) have a negative impact on AVA. Agricultural inputs and outputs have increased in price, making products more expensive. As a result, production costs are higher than usual and aggregate demand is smaller (Jankulovski et al., 2021). Inflation has lowered output and income growths, making it difficult for farmers to purchase agricultural inputs at optimal quantities (Bleaney and Francisco, 2016; Gonzales and Rojas-Hosse, 2019). Inflation also reduces investment in the MENA, particularly in the agricultural sector

(Okafor et al., 2017). Furthermore, being one of the world's top grain importers, the MENA region is particularly vulnerable to rising global food prices. For example, the 2007 food price crisis is recognized as causing the greatest cost-push inflation, with the food price index rising from 134.0 to 210.9 between 2007 and 2012 (FAO, 2021). As a result, it will disrupt AVA's growth in the MENA region. Our result is consistent with Zaman et al. (2016) study findings that show inflation will reduce value-added even in developed countries.

According to this study's findings, EGI inhibited the increase in AVA. EGI in the MENA region does not always have a positive impact, for example, EGI can potentially increase CO_2 emissions (Yurtkuran, 2021). This finding contrasts with Nugroho et al. (2021), who stated that EGI positively impacted AVA in developing countries. This difference in results is common in the economic sphere. Adam Smith and David Ricardo said that liberalization would make a country's products more competitive (Salvatore, 2013). However, Scholte (2005) stated that EGI is not beneficial for developing countries because a single global-Western conglomerate controls globalization.

EGI has encouraged agriculture's capitalization, commercialization, and commoditization in the MENA region. However, the disadvantages of these activities appear to exceed the advantages. Whereas, in line with the implementation of EGI, the governments of MENA have implemented a variety of policies and programs, including the provision of inputs, credits, and extension services, promotion of modern farming technologies, the introduction of new crop varieties, support for the establishment of agricultural associations and cooperatives, state farms, parastatal marketing and distribution agencies, and the state to extend and intensify commodity product (Aydin, 2010).

The implementation of the EGI appears to have resulted in a deficit in the MENA agricultural trade balance. MENA's agricultural exports were higher than imports in the early 1970s. However, since the early 1980s, this situation has flipped, with agricultural imports now outnumbering exports (FAO, 2021). Despite the MENA region supplies food to the EU, Asia, and America (Freund and Braga, 2012), it is also the world's largest grain importer (Keulertz and Woertz, 2015). Furthermore, countries in the MENA region are focusing more on oil exports while diversifying their economies in other sectors, such as agriculture, which is still behind (Kireyev, 2021). These various conditions make EGI reduces AVA.

Meanwhile, three variables did not significantly impact AVA, namely agricultural land use (LAND), nutrient nitrogen N (NUT), and temperature change (TEMP). LAND use in MENA is inefficient, so it does not affect AVA. This is usually due to the inefficient use of agricultural inputs. For example in Tunisia, inefficient water use causes a loss of economic value, including in agriculture, amounting to 470 million Tunisian Dinars (Chebil et al., 2019). Meanwhile, inefficiency has resulted in lower agricultural yields and production patterns that are tilted away from high-value commodities in Egypt (Osman et al., 2019). Finally, Iran will have to spend a lot of money to enhance agricultural management (Tahbaz, 2016). A similar thing happens in the MENA when it comes to the use of NUT. Many farmers in the MENA do not utilize NUT efficiently (Houshyar et al., 2012; Mardani and Salarpour, 2015). As a result, NUT application did not influence AVA growth. A causal relationship exists between TEMP and AVA. In this study, TEMP did not affect AVA. This aligns with research Ozturk (2017), which states that only AVA affects TEMP in MENA but not vice versa.

Conclusion

According to our findings, various factors can boost AVA in the MENA region, including land areas equipped for irrigation (IRRI), domestic agricultural credit (CRED), and the human capital index (HCI). On the other hand, inflation (INF) and the economic globalization index (EGI) have a negative impact on AVA. Only EGI got the opposite result as predicted out of all the factors. Moreover, we show that Diamond Porter's theory can be applied to agriculture. Theories related to company competitiveness are influenced by factor conditions, demand conditions, related and supporting, and firm strategy, structure, and rivalry.

Based on the findings of this study, we recommend several things:

1. Governments in the MENA region must invest more in infrastructure, particularly irrigation. This is important because many farmlands in MENA are not irrigated. The government must also upgrade irrigation channels or implement precision irrigation management, for example subsurface drip irrigation for food crops (Wang et al., 2022) or subsurface irrigation with ceramic emitters for annual crops (Cai et al., 2021), considering that the majority of MENA is a dry area. The most vital concern is considering irrigation as a "social asset," implying that the community must contribute to its maintenance.
2. The government in the MENA region needs to expand the credit scheme to rural areas of agricultural centers. This is done by developing banks or cooperatives in rural areas. Likewise, the credit value for agriculture must be gradually increased so that farmers can increase the quantity and quality of products as well as the number of agricultural inputs and machines. The government must also enforce regulations to ensure that loan interest rates are low so that farmers can benefit significantly, as has been the case in other countries, like farm credit program in Indonesia (Mariyono, 2018).

3. It is critical to continue to invest in agriculture's human capital, both *via* training and education. Especially now, when agricultural technology is rapidly evolving. However, due to the inability to operate this complicated technology, adoption at the farm level is still slow. One more thing that must be done is the improvement of research and development to produce agricultural innovations, for example drought tolerant plant varieties (Anbazhagan et al., 2022).
4. Fiscal policy management, particularly inflation control, is also vital for governments in the MENA region to increase AVA. Moreover, the current global situation is uncertain, causing prices for numerous inputs and agricultural products to rise rapidly.
5. The policy of regulating economic globalization has always been a dualism in various countries, including developed countries. On the one hand, if EG is left without government intervention, domestic agriculture will be disrupted. However, if the government intervenes too excessively, this violates the EG principle. The solution to this dualism is to apply EG like "release the dog but keep him on a leash." This means implementing EG, but at a specific moment, the government must intervene, especially when the impact of EG begins to disrupt agriculture. Then, when the situation returns to normal, the government must allow the use of EG to continue.

As researchers, we believe that the analytical methods used in this study have limitations because static panel data analysis is prone to serial correlation and heteroscedasticity issues, which lead to biased and inconsistent estimates, also known as endogeneity problems. As a result, we recommend additional research using dynamic panel data analysis techniques such as the Generalized Method of Moments (GMM) and system GMM (sys-GMM).

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in the article/Supplementary material.

Author contributions

AN designed the study with input from FI, MF-F, and ZL. AN contributed to collecting data and data interpretation and leads the data analysis with input from all authors. All authors contributed to writing the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2022.956701/full#supplementary-material

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