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Impact of food security on sustainable development in Arab countries during the period 1995-2021

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***Abstract*---**This study aims to measure the impact of food security on the three primary dimensions of sustainable development (economic, social, and environmental) in a sample of Arab countries over the period 1995-2021. The study adopts the Feasible Generalized Least Squares (FGLS) estimation method. The three dimensions of sustainable development are represented by economic growth rates, unemployment rates, and carbon dioxide emissions, respectively. These dimensions are explained by a food security index and a set of secondary independent variables. The study found that static panel data models are inefficient in estimating the relationship between the variables of the three proposed models. Moreover, the results indicate that the food production index has a positive impact on economic growth rates and contributes positively to reducing unemployment rates and carbon dioxide emissions in the sample countries.

***Keywords*---**food security, sustainable development, Feasible Generalized Least Squares, Arab countries.

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I. Introduction

The food system revolves around the key objectives of the Food and Agriculture Organization, which include poverty reduction, food security, and nutrition in general. It is an integral part of the broader system performance, referring to the three dimensions of sustainability: economic, social, and environmental. This performance is determined by the behavior of various actors, or stakeholders in the food system, generally related to the consumer (the human resource).

This behavior, in turn, occurs within the system's structure, consisting of a core system, societal elements, natural elements, and others. Therefore, the food system, which primarily includes food security as the second Sustainable Development Goal, through which sustainability is examined as a whole, requires generating positive value on three dimensions simultaneously for development to be sustainable: economic and social. Economically, food security is considered sustainable if the activities of each actor in the food system or the service provider are commercially or financially viable. Activities must generate benefits or added economic value for all stakeholders, including wages for workers, taxes for governments, profits for institutions, and improved food supplies for consumers. Socially, food security is considered sustainable when there is equitable distribution of added economic value, taking into account vulnerable groups classified by gender, age, race, etc., so that food security activities contribute to advancing important social and cultural outcomes such as nutrition, health, traditions, working conditions, and animal welfare.

Therefore, food security influences sustainable development through its interaction with the fundamental dimensions that constitute it. From this perspective, the research problem is posed in the following question:
What is the impact of food security on the fundamental dimensions of sustainable development in Arab countries during the period 1995-2021?

The significance of this research lies in understanding the impact of food security on the dimensions of sustainable development in a selected group of countries during the period 1995-2021. This is because the topic of food security is vast and has been extensively explored by researchers, entrepreneurs, and policymakers alike, with the aim of achieving the global goal of sustainable economic development and growth.

Through this paper, various previous theories and empirical studies on food security and the dimensions of sustainable development will be explored using a descriptive approach. Additionally, the relationship between the two will be measured, and the impact of food security on the dimensions of sustainable development in the sample of Arab countries during the period 1995-2021 will be identified. In line with these objectives, this research paper is divided into: previous studies, concepts related to the research topic, and empirical analysis.

II. Literature review

Food security is a fundamental component of sustainable development, playing a crucial role in various aspects of achieving sustainable development goals. Ensuring food security is essential for human well-being and economic progress (Echendu, 2022). The impact of food security on sustainable development is evident in the context of poverty alleviation, environmental conservation, and infrastructure development (Ibitoye, 2024; Yusriadi, 2023). Sustainable agriculture, which enhances food security, is vital for poverty reduction, aligning with the objectives of sustainable development outlined by the United Nations (Yusriadi, 2023). Additionally, reducing food losses and waste not only conserves natural resources but also contributes to achieving sustainable development goals related to hunger and responsible consumption and production (Kapsdorferova et al., 2021).

The relationship between food security and sustainable development is further emphasized by the need for sustainable food security practices that are compatible with overall sustainable development objectives (Qi et al., 2012). Studies have shown that promoting agricultural development and ensuring food security are key priorities within the sustainable development agenda (Pestryakov et al., 2021). Establishing a comprehensive food security evaluation system based on sustainable development principles is crucial for assessing and enhancing food security within a region (Chen, 2023). Furthermore, food security is intricately linked to all United Nations Sustainable Development Goals, highlighting its significance in the broader sustainable development framework (Pérez-Escamilla, 2017).

Efforts towards sustainable food security involve effective governance, policy alignment, and interventions that support the transition towards sustainable development (Aassouli, 2023; Richardson, 2010). Agricultural sustainability, driven by public investments and producer prices, plays a significant role in achieving food security goals within the context of sustainable development (Kwaw-Nimeson & Tian, 2021). Integrating food security into the sustainability agenda is essential for addressing global health, nutrition, and environmental challenges (Berry et al., 2015). Moreover, sustainable intensification of agriculture through improved water use is crucial for meeting the growing demand for food and achieving sustainable economic development (Iortyom & Kargbo, 2023).

The impact of food security on the fundamental dimensions of sustainable development in Arab countries from 1995 to 2021 is a multifaceted issue that encompasses economic, social, and environmental dimensions. Food security is not merely a matter of ensuring sufficient food availability; it also involves accessibility, utilization, and stability of food supplies, which are crucial for sustainable development. The interplay between food security and sustainable development is particularly pronounced in the Arab region, where challenges such as water scarcity, climate change, and socio-economic disparities exacerbate food insecurity.

To begin with, the economic dimension of sustainable development is significantly influenced by food security in Arab countries. The reliance on food imports due to limited agricultural production capabilities has made many Arab nations vulnerable to global market fluctuations and price volatility. For instance, highlight that severe shortages of water and arable land constrain agricultural production, necessitating a heavy reliance on imports, which in turn affects economic stability and growth (Khouri et al., 2011). This dependency can lead to increased food prices and economic strain, particularly during crises such as the COVID-19 pandemic, which disrupted supply chains and heightened food insecurity (Teng, 2020). Furthermore, the inefficiencies in agricultural practices, as noted by, including poor water management and outdated technologies, have hindered the potential for self-sufficiency and economic resilience in the region (Mustafa, 2020). Socially, food security is intrinsically linked to health and well-being, which are critical components of sustainable development. The Arab region faces a paradox of malnutrition, where both under-nutrition and over-nutrition coexist, leading to a dual burden of disease (Musaiger et al., 2011). This situation is exacerbated by socio-economic inequalities, where marginalized populations often lack access to nutritious food, thereby impacting their health outcomes and productivity. emphasize the need for multi-sectoral interventions that address the political, economic, and social factors contributing to nutrition-related diseases in the Arab countries (Musaiger et al., 2011).

The social fabric of these nations is thus at risk, as food insecurity can lead to social unrest and instability, further complicating efforts toward sustainable development. The environmental dimension of sustainable development is also critically impacted by food security in the Arab region. The region's arid climate poses significant challenges for agricultural productivity, with water scarcity being a primary concern. discuss the historical adaptations of Arab societies to arid landscapes through innovations in water management, yet they note that rapid urbanization and population growth are straining these systems (Borgomeo et al., 2020). The unsustainable use of water resources for agriculture, coupled with climate change, threatens to exacerbate food insecurity and hinder sustainable agricultural practices. The potential of small-scale rainfed agriculture to enhance food security is highlighted by who argue that such practices could mitigate some of the adverse effects of climate change on food production (Haddad et al., 2011).

However, without adequate investment in sustainable water management and agricultural technologies, the region's food security remains precarious. Moreover, the interconnections between food security and the Sustainable Development Goals (SDGs) cannot be overlooked. The SDGs emphasize the importance of ending hunger and ensuring food security as foundational to achieving broader sustainable development objectives. The Arab region's progress towards these goals has been uneven, with some countries making strides in agricultural innovation and food systems, while others continue to struggle with high levels of food insecurity. The need for comprehensive policies that integrate food security into national development strategies is critical. As noted by, economic diversification and improved governance are essential for addressing the underlying challenges of food insecurity in the Arab world (Breisinger et al., 2012).

In conclusion, the impact of food security on sustainable development is profound and multifaceted. By addressing food security challenges through sustainable agricultural practices, reduced food waste, and effective governance, countries can make significant strides towards achieving sustainable development goals and ensuring long-term economic, social, and environmental sustainability.

III. Empirical Study:

1- Methodology and Model Specification:

comprehensively address the research problem, which primarily revolves around measuring the impact of food security on the dimensions of sustainable development in a sample of countries during the period 1995-2021, the study sample includes Algeria, Tunisia, Morocco, Egypt, Qatar, the United Arab Emirates, Jordan, Oman, and Saudi Arabia. The sample was selected based on the availability of data throughout the study period.

Furthermore, the econometric models used in this study were described based on the applied literature on the research topic and the specific characteristics of the economies of the sample countries. Given the research problem addressed in this paper, which targets the three main dimensions of sustainable development (economic, social, and environmental), three independent econometric models will be adopted. The general formulation of the study models can be written as follows:

$$lnPCGDP_{it} = \hat{\beta}_0 + \hat{\beta}_1 \mathrm{lnFIMP}_{it} + \hat{\beta}_2 \mathrm{lnPOP}_{it} + \hat{\beta}_3 \mathrm{lnLABORINPUT}_{it} + \hat{\beta}_4 \mathrm{lnFEXP}_{it} + \hat{\beta}_4 \mathrm{lnLCER}_{it} + \hat{\beta}_5 \mathrm{lnFPI}_{it} + \varepsilon_{it}$$

$$lnUNMPL_{it} = \hat{\beta}_0 + \hat{\beta}_1 \mathrm{lnFIMP}_{it} + \hat{\beta}_2 \mathrm{lnPOP}_{it} + \hat{\beta}_3 \mathrm{lnLABORINPUT}_{it} + \hat{\beta}_4 \mathrm{lnFEXP}_{it} + \hat{\beta}_4 \mathrm{lnLCER}_{it} + \hat{\beta}_5 \mathrm{lnFPI}_{it} + \varepsilon_{it}$$

$$lnCO2_{it} = \hat{\beta}_0 + \hat{\beta}_1 \mathrm{lnFIMP}_{it} + \hat{\beta}_2 \mathrm{lnPOP}_{it} + \hat{\beta}_3 \mathrm{lnLABORINPUT}_{it} + \hat{\beta}_4 \mathrm{lnFEXP}_{it} + \hat{\beta}_4 \mathrm{lnLCER}_{it} + \hat{\beta}_5 \mathrm{lnFPI}_{it} + \varepsilon_{it} \quad (\mathrm{n}: 1 \dots \mathrm{N})(\mathrm{t} = 1 \dots \mathrm{T})$$

The parameter $\hat{\beta}_0$ represents the intercept, while $\hat{\beta}_1$، $\hat{\beta}_2$،$\widehat{\beta_1}$، $\hat{\beta}_k$ are the estimated coefficients for the study variables. The subscript)i(represents the countries, and (t) represents the years. Regarding the study variables, their units of measurement, and data sources, they are presented in the following table:

Table 1: Sources and Units of Measurement for Study Variables

Variable type	Variables	Description	Source
Dependent variable	LnPCGDP	Economic Dimension: Economic Growth (GDP per capita)	World Bank
	LnUNMPL	Social Dimension: Unemployment Rate	World Bank
	lnCO2	Environmental Dimension: CO2 Emissions (per capita in metric tons)	World Bank
Independent variable	FPI	Food Production Index (2004-2006=100)	FAO
	LCER	Land Cultivated with Grains (hectares)	World Bank
	FEXP	Food Exports (% of merchandise exports)	World Bank
	FIMP	Food Imports (% of merchandise imports)	World Bank
	POP	Total Population (number of people)	World Bank
	LABORINPU	Employment in Agriculture (% of total employment)	World Bank

Source: Prepared by the researchers based on previous studies.

As shown in the table above, international official sources were relied upon to collect the data due to the inconsistency of statistics issued by the local authorities in the sample countries. It is also worth noting that the natural logarithm was applied to all study variables to ensure unit homogeneity and reduce the magnitude of variations resulting from unit differences, thereby ensuring more accurate econometric results.

2. Descriptive Analysis of the Data:

To provide an initial overview of the data used in the study, the main statistical characteristics of these data will be presented by displaying a set of central tendency statistics in the following table:

Table 2: Descriptive Analysis of Study Variables

UNMPL	CO2	PCGDP	FPI	
8.18	12.78	19615.91	85.08	Mean
7.45	6.28	10296.30	86.29	Median
31.84	47.66	73493.27	185.23	Maximum
0.10	1.06	1692.85	26.79	Minimum
6.43	12.60	20327.31	27.22	Std. Dev.
0.89	0.96	1.04	0.38	Skewness
3.81	2.92	2.86	3.33	Kurtosis
270	270	270	270	Observations

Source: Prepared by the researchers based on the outputs of STATA 17 software.

By interrogating the numbers presented in the table above, the following observations can be drawn:

The arithmetic mean of the variable “GDP per capita,” which represents economic growth in the sample countries, was $19,615.91. This is a high average compared to the global average of $10,442 (World Bank, 2023). On the other hand, the arithmetic mean of the Food Security Index in the sample countries was 85.08, which is somewhat low. This reflects that the sample countries achieved high levels of food security over wide periods of the study. Regarding unemployment rates and carbon dioxide emissions, their arithmetic means were as follows.

The arithmetic mean of the variable for per capita GDP, which represents economic growth in the sample countries, was $19,615.91. This is a high average compared to the global average of $10,442 (World Bank, 2023). On the other hand, the arithmetic mean value of the food security index in the sample countries was 85.08, which is somewhat low. This reflects that the sample countries managed to achieve high levels of food security over wide periods of the study. Regarding unemployment rates and carbon dioxide emissions, their arithmetic means were calculated respectively.

From the results shown in the table above, it can be observed that there is a variation in the standard deviation values among the study variables. For the dependent variable (PCGDP) and the main independent variable (FPI), the standard deviations were high, while the deviations for the rest of the variables were relatively low. This is primarily due to the differences in measurement units for the study variables, especially for those with high deviations. Therefore, the high variation in the observations for these variables is due to the differences in measurement units, meaning it does not represent true and high deviations from the mean. To overcome this issue and ensure the robustness and homogeneity of the study model variables, the natural logarithm was applied to all study variables. This step also allows for more accurate calculation of elasticities during estimation.

2- Estimation of Basic Panel Data Models and Comparison Between Them:

As previously mentioned, three separate models were adopted, each measuring the impact of food security on each dimension of sustainable development. Given the existence of three basic static panel data models, the total estimated models are nine (09). The researchers summarized the estimation results in the table below, including the basic results of the comparison tests. This was done to comprehensively address all aspects of the issue within the paper’s limits in a more concise and accurate manner.

Table No. (03): Estimation of Basic Panel Data Models and Comparison Tests Between Them

Explanatory Variables / Comparison Tests lnPCGDP	Dependent Variable: lnPCGDP			Dependent Variable: lnUNMPL			Dependent Variable: lnCO2		
	PRM	FEM Coef.	REM	PRM	FEM Coef.	REM	PRM	FEM Coef.	REM
lnLABORINPUT	-0.05	-0.20*	-0.19*	-0.03*	0.61*	0.45*	-0.15*	- 0.11**	-0.13*
lnPOP	0.01	-0.38*	-0.38*	0.09*	0.30*	0.09	-0.07	-0.45*	-0.47*
lnFIMP	-0.19	-0.16*	-0.16*	0.17*	-0.01	-0.01	-0.06	-0.33*	-0.32*
lnFEXP	-0.21*	-0.08*	-0.07	0.25*	0.12	0.11*	-0.22*	-0.01	-0.01
lnLCER	-0.20*	-0.07*	-0.06	0.15*	0.24*	0.19*	-0.15*	-0.05	-0.05
lnFPI	0.46*	0.38*	0.38*	-0.34*	-0.16	-0.09	0.45*	0.41*	0.42*
_cons	10.05*	15.33*	15.23*	-0.54*	-6.50*	-2.63*	3.42*	9.05*	9.31*
R-sqr	0.8	0.80	0.90	0.76	0.71	0.72	0.87	0.7	0.71
F-stat/ Wald	26.22*	204.87*	397.67*	139.35*	18.25*	117.01*	320.91*	35.12*	241.02*
The “Restricted ,9) Fisher Test F(254		243.92*			79.82*			298.85*	
(hausman)		41.39*			9.09			5.05	
Breusch and) (Pagan		1505.08*			1402.25*			1486.8*	

a: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1% and (no) Not Significant

Source: Prepared by the researchers based on the outputs of STATA 17 software

After estimating all the study models, this stage will attempt to identify the source of differences or variations among the sample countries in the impact of food security on each dimension of sustainable development, based on comparison tests. In the next stage, the most efficient model will be analyzed based on the comparison tests from a statistical perspective (partial and overall significance, as well as explanatory power).

- **Comparison Tests and Statistical Analysis for the Economic Dimension Model**

For the first model, which pertains to the economic dimension of sustainable development, the statistical value of the Restricted Fisher Test (F-stat=243.92) was statistically significant at a significance level of less than 5%, considering that the associated p-value was (0.00). This means we cannot accept the null hypothesis of the test, which states that the pooled model is better than the fixed effects model. Regarding the Breusch and Pagan test, the results showed that the statistical value of this test was significantly greater than the corresponding tabular value at significance levels of less than 5%. Therefore, we can accept the alternative hypothesis of this test, which states that either the fixed effects or random effects models are better than the pooled model. The distinction between the fixed effects and random effects models was made based on the Hausman test, which showed that the random effects model is more efficient than the fixed effects model. Therefore, the focus will be on the random effects model for the economic dimension, based on the comparison test results shown in the previous table.

Referring to the previous table, the explanatory power of the random effects model (R^2=0.80) indicates that the independent variables account for 80% of the variations in the economic growth rates of the study sample. The remaining percentage is due to other factors not included in the model but accounted for in the error margin. Regarding the partial significance of the parameters and the overall significance of the random effects model, the estimation results showed the presence of these properties. All the information related to the independent variables in the fixed effects model is statistically significant at a 5% significance level.

Additionally, the statistical value of the Fisher test is also statistically significant at the same significance level, considering that the associated p-value is much lower than the critical value (0.05). Overall, the random effects model for the economic dimension of sustainable development can be accepted statistically due to its partial and overall significance properties, as well as its high explanatory power. Before adopting this model for economic analysis, it is necessary to diagnose the residuals of the model estimation from an econometric perspective, which will be verified in the following points.

- **Comparison Tests and Statistical Analysis for the Social Dimension Model:**

Regarding the second dimension of this study, the results of both the Restricted Fisher Test and the Breusch and Pagan test indicated that the fixed and random effects models are more efficient than the pooled model. This suggests the presence of individual differences, whether fixed or random, among the sample countries. The results of the Hausman test showed that the fixed effects model is the most suitable for measuring the impact of food security on the social dimension of sustainable development, as the p-value for this test was significantly greater than the critical value (0.05), leading to the acceptance of the null hypothesis.

For the partial significance of the aforementioned model, which includes fixed effects, the information related to the variables of food exports and imports relative to total exports and imports, and the food security index, appeared statistically insignificant at significance levels below 5%. The explanatory power of this model was 71%, which is also high, indicating the ability of the independent variables to explain changes in unemployment rates.

Overall, the fixed effects model that measures the impact of food security on unemployment rates in the sample countries can be statistically accepted due to the partial significance of most model parameters, the overall significance based on the Fisher statistic, and the high explanatory power of this model.

- **Comparison Tests and Statistical Analysis for the Environmental Dimension Model:**

Based on the comparison tests shown in the previous table, it appears that the most efficient model for measuring the impact of food security on the environmental dimension of sustainable development is the fixed effects model. The results of the Restricted Fisher Test and the Breusch and Pagan test indicated that the fixed or random effects models are more efficient than the pooled model. Meanwhile, the Hausman test showed that the fixed effects model is the most suitable for measuring the impact of food security on the environmental dimension of sustainable development, which will be adopted in the statistical and econometric analysis for this dimension.

Regarding the partial significance of the fixed effects model that measures the impact of food security on the environmental dimension of sustainable development, the estimation results showed that all the information related to the explanatory variables is statistically significant at a 5% significance level, considering that the p-values associated with these parameters are all much lower than the critical value (0.05), except for the parameters related to food exports and imports of the sample countries. The model also features overall significance, as the Fisher statistic for this model was (F-stat=35.12), which is statistically significant at the 5% significance level. Therefore, the model is significant overall. Additionally, the explanatory power of the model was 70%, indicating that the independent variables contribute to explaining changes in carbon dioxide emissions to a high degree.

3- Diagnosis of Preferred Models and Correction of Measurement Issues:

Before analyzing the results obtained from the study models from an economic perspective, as indicated by the comparison tests, the efficiency of the selected models will first be verified from an econometric perspective. This involves testing for the absence of autocorrelation and heteroscedasticity in the residuals of these models, as these issues negatively impact the efficiency and accuracy of econometric estimation results and their reliability in economic analysis. Additionally, the independence of the cross-sections or sample units will be tested at this stage. Based on the presence or absence of measurement issues and the type of issues identified, the estimation method that corrects these problems will be chosen, considering that the length of the time period is greater than the number of cross-sections or sample units.

Table No. (04): Results of Measurement Issues Tests for Study Models

Dependent Variable: lnPCGDP			
Wooldridge test for autocorrelation in panel data			
F(1,9)	295.348	Prob> F	0
Panel Groupwise Heteroscedasticity Tests			
Likelihood Ratio LR Test	146.3839	P-Value > Chi2(9)	0
Pesaran's test of cross sectional independence			
V-stat	2.648	Prob	0.046
Dependent Variable: lnUNMPL			
Wooldridge test for autocorrelation in panel data			
F(1,9)	28.252	Prob> F	0
Modified Wald test for groupwise heteroskedasticity			
Likelihood Ratio LR Test	1646.35	P-Value > Chi2(9)	0
Pesaran's test of cross sectional independence			
V-stat	-1.42	Prob	0.361
Dependent Variable: lnCO2			
Wooldridge test for autocorrelation in panel data			
F(1,9)	58.903	Prob> F	0
Panel Groupwise Heteroscedasticity Tests			
Likelihood Ratio LR Test	121.62	P-Value > Chi2(9)	0
Pesaran's test of cross sectional independence			
V-stat	0.804	Prob	0.4211

Source: Prepared by the researchers based on the outputs of STATA 17 software

For the first model, which pertains to the economic dimension of sustainable development, the statistical value of the Wooldridge test with degrees of freedom (1; 9) was (295.34), which is significantly greater than the corresponding tabular value at a 5% significance level with the same degrees of freedom. Therefore, we can accept the alternative hypothesis of the test, which states that the random effects model for the economic dimension suffers from the problem of autocorrelation among its errors. The results of the heteroscedasticity and cross-sectional independence tests showed that the aforementioned model suffers from heteroscedasticity, considering that the p-value for the Panel Groupwise Heteroscedasticity Tests and Pesaran's test of cross-sectional independence was much lower than the critical value (0.05).

Regarding the fixed effects models for the social and environmental dimensions, the statistical values of the Wooldridge tests for these models were (28.25; 58.90) respectively, which are significantly greater than the corresponding tabular values at a 5% significance level. Therefore, we accept the alternative hypothesis of the test, which states that the residuals of these models are autocorrelated. The same observation applies to the problem of heteroscedasticity of the residuals, as the p-values for the tests were much lower than the critical value for both models, meaning we accepted the alternative hypothesis of the test. On the other hand, the results of the cross-sectional independence tests for the social and environmental dimension models showed that the cross-sections are completely independent, as the p-values for the tests were much greater than the critical value (0.05), meaning we accepted the null hypothesis of the test.

IV. Results and Discussion

Based on the results of the measurement issues tests, which showed that the economic dimension model with random effects suffers from autocorrelation among errors, heteroscedasticity, and non-independence of cross-sections, and that the fixed effects models for the social and environmental dimensions also suffer from autocorrelation among errors and heteroscedasticity with independent cross-sections, the most appropriate estimation method for the economic dimension model with random effects is the Feasible Generalized Least Squares (FGLS) method, which accounts for autocorrelation, heteroscedasticity, and cross-sectional dependence. For the fixed effects models for the social and environmental dimensions of sustainable development, the most appropriate estimation method is the Panels Corrected Standard Errors (PCSE) method, as indicated by (Hoechle , 2007, p. 285), which is shown in the table below:

Table No. (05): Estimation of Study Models with Correction of Measurement Issues

generalized least squares			heteroskedastic panels corrected standard errors		heteroskedastic panels corrected standard errors	
heteroskedastic with cross-sectional correlation			Heteroskedastic		Heteroskedastic	
common AR(1) coefficient for all panels (0.8573)			common AR(1)		common AR(1)	
Dependent Variable: lnPCGDP			Dependent Variable: lnUNMPL		Dependent Variable: lnCO2	
LnPCGDP	Coef.	P>z	Coef.	P>z	Coef.	P>z
LnLABORINPUT	0.347	0	-0.304	0.000	0.112	0.044
LnPOP	-0.298	0	0.300	0.000	0.455	0.050
LnFEXP	0.016	0.01	-0.085	0.036	0.328	0.041
LnFIMP	-0.061	0.004	-0.036	0.000	0.009	0.013
LnLCER	0.062	0	-0.074	0.000	-0.046	0.017
LnFPI	0.244	0	-0.207	0.000	-0.414	0.035
_cons	14.520	0	7.533	0.000	9.054	0.876
Wald chi2(6)		1718.86	F(6,254)	1010.08	F(6,254)	116.72
Prob > chi2		0	Prob > F	0.000	Prob > F	0.000

Source: Prepared by the researchers based on the outputs of STATA 17 software.

Regarding the partial significance of the parameters associated with all study variables in the models for the three dimensions of sustainable development, the results shown in the table above indicate that most parameters are statistically significant at significance levels below 5%. This is because the p-values for the Student's t-statistic for most estimated parameters are much lower than the critical value (0.05), meaning we accepted the alternative hypothesis of the Student's t-test. There is a single exception for the parameter associated with the total investment variable (lnPOP) in the environmental dimension model, where the p-value for the Student's t-statistic was (0.05), which is approximately equal to the critical value (0.05).

Referring to the results shown in the table above, the Fisher statistic values (F-stat=1010.08, 116.72) for the fixed effects models for the social and environmental dimensions, respectively, are greater than the corresponding tabular values at a 5% significance level, considering that the associated p-values are much lower than the critical value (0.05). Additionally, the Chi-square statistic for the economic dimension model was (1718.86), which is also statistically significant, leading to the acceptance of the alternative hypothesis for the tests of the three models, which states that all models are statistically significant overall.

Overall, the three models estimated using the (FGLS - PCSE) methods are statistically acceptable, considering the presence of partial and overall significance properties, as well as the absence of measurement issues in the aforementioned models. Therefore, the results obtained can be relied upon for economic analysis with a high degree of reliability."

4- **Economic Interpretation of the Results**

- **Economic Interpretation of the Economic Dimension Model:**

The postive sign of the parameter associated with the food security index in the sample countries indicates the positive impact of this index on economic growth rates. An increase in the index value signifies a deterioration in the country's food security, and vice versa. Therefore, a 100% decrease in the index value can drive economic growth by approximately 24%. This high elasticity reflects a significant impact of food security on economic growth, as improving food security leads to better health and increased productivity of individuals. Healthier individuals are more capable of working and producing, contributing to economic growth. Additionally, children who receive good nutrition are better able to learn and achieve academically, enhancing human capital in the long term, which directly contributes to increased economic growth rates in the sample.

The positive sign of the parameters associated with the variables of the area of land cultivated with cereals, total food exports, and employment in the agricultural sector (lnLCER, lnLABORINPUT, lnFEXP) indicates the positive impact of these variables on the economic dimension of sustainable development in the sample countries. An increase in these variables by 100% can drive economic development by approximately 34%, 1%, and 6%, respectively. Conversely, the variables of population growth and food imports negatively affect economic growth rates in the sample countries, with elasticities of 29% and 6%, respectively.

- **Economic Interpretation of the Social Dimension Model:**

The positive sign of the parameter associated with the food security index in Arab countries indicates the positive impact of this index on unemployment rates. An increase in the food security index by 100% can lead to an increase in unemployment rates by approximately 20%. Deterioration in food security can reduce the number of individuals capable of working due to malnutrition and diseases, decreasing the labor supply.

The positive sign of the parameters associated with the variables of the area of land cultivated with cereals, total food exports and imports, and employment in the agricultural sector (lnLCER, lnLABORINPUT, lnFEXP, lnFIMP) indicates the positive impact of these variables on unemployment rates in the sample countries. An increase in these variables by 100% can drive economic development by approximately 7%, 3%, 30%, and 7%, respectively. Conversely, the population growth variable negatively affects unemployment rates in the sample countries, with an elasticity of 30%.

- **Economic Interpretation of the Environmental Dimension** model:

The negative coefficient associated with the food production index suggests that an increase in food production is linked to a decrease in carbon dioxide emissions. Specifically, our results show a 41% elasticity, indicating a significant negative relationship. Likewise, the variable representing cultivated cereal areas exhibited a positive impact on reducing CO_2 emissions. However, the other explanatory variables demonstrated a statistically significant positive relationship with carbon dioxide emissions, implying that they contribute to higher levels of emissions.

V. Conclusion

In conclusion, the impact of food security on the fundamental dimensions of sustainable development in Arab countries from 1995 to 2021 is profound and multifaceted. Economic vulnerabilities stemming from reliance on food imports, social challenges related to malnutrition, and environmental pressures due to water scarcity all intertwine to create a complex landscape for sustainable development. Addressing these issues requires a holistic approach that encompasses policy reforms, investment in sustainable agricultural practices, and a commitment to improving the socio-economic conditions of vulnerable populations. The path forward must prioritize food security as a cornerstone of sustainable development, ensuring that all individuals have access to sufficient, safe, and nutritious food to lead healthy lives.

The researchers attempted to address the issue of the impact of food security on sustainable development in a sample of Arab countries from 1995 to 2021, using static panel data analysis. A set of results was recorded, which can be summarized as follows:

The differences among the sample of Arab countries in the impact of food security on the economic dimension of sustainable development are due to the random element, meaning there are random individual differences among the sample countries. In contrast, the differences in both the environmental and social dimensions are due to the fixed components that distinguish each country in the sample. This paper has revealed that:

Economic Dimension:

- **Food Security:** A deterioration in food security (measured by the food security index) leads to an increase in economic growth rates. Specifically, a 100% decrease in the index can drive economic growth by approximately 24%.
- **Other Variables:** An increase in the area of land cultivated with cereals, total food exports, and employment in the agricultural sector positively impacts economic growth. Conversely, population growth and food imports have negative effects.

Social Dimension:

- **Food Security:** A deterioration in food security leads to an increase in unemployment rates. A 100% increase in the food security index can lead to a 20% increase in unemployment.
- **Other Variables:** An increase in the area of land cultivated with cereals, total food exports, and employment in the agricultural sector positively impacts unemployment rates. Population growth has a negative effect.

Environmental Dimension Model:

- **Food Production:** An increase in food production (measured by the food production index) is associated with a **decrease** in carbon dioxide emissions. This relationship is significant, with a 41% elasticity.
- **Other Explanatory Variables: :** Expanding the area of land cultivated with cereals can also contribute to **reducing** carbon dioxide emissions, Other factors included in the model have a **positive** impact on carbon dioxide emissions, suggesting they contribute to increased emissions.

The impact of food security in the sample countries can be enhanced by focusing on a set of factors summarized as follows:

- Ensuring affordable food availability: Through fair pricing policies and support for the most vulnerable groups.
- Improving storage and distribution: By investing in infrastructure to improve access to, storage, and distribution of food.
- Encouraging sustainable agriculture: By providing support to farmers to use sustainable agricultural techniques.

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