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# Food Security in the Middle East and North Africa (MENA)

With regards to the population growth and urbanization growth, food supply and food security both are among one of the most serious challenges for the countries of the Middle East and North Africa and such challenge can become as the main dilemma and problem for MENA region countries together with the global crises, regional crises and climatic changes. Since these countries are dependent on the imports of the foodstuffs in spite of their remarkable income which results from the both oil & gas exports accordingly any economic and political shock may endanger and jeopardize the food supply in the countries of the foregoing region. Hence, improving the political, commercial relations and the governments' performance which are done for reducing the tensions and all vulnerabilities arising out of the food insecurity will have a great role. In this research, we have studied the effects of institutional, economic and climatic indexes on the food security in MENA region using FMMs method within the time interval of 1995–2019 with regards to the significance of the role of institutional variables together with the economic and climatic ones.  Results of this research show that in spite of the governments' endeavours for ensuring the food security, therefore, the food crisis concern will be assumed as a serious one throughout this region due to the failure of the existence of required participation and interaction among the government, private sector and people and the main reason for the above-said crisis is because of the infirmity of institutional variables in the countries existing in MENA regions which include the governance, prosperity, democracy and economic freedom and it should be noted that the war and tensions existing in the region can be known as one of the other drastic coefficients on the food insecurity.

## Introduction

The food security exists when all individuals at all times are of physical and economic availability towards the sufficient, safe and rich food and so that they could meet their

own needs to foods and nutritional preferences for an active and healthy life (World Food Summit, 1996). This definition involves some cases such as the food availability, the economic and social food access, the individual ability for changing the food that is eaten by an individual to the good health consequences and persons' ability (Utilization) for maintaining the stability in the above-mentioned cases and during the time (FAO, 2015).

Ensuring the food security is a global challenge which is not only limited to provide the people with their food and it is related to the whole aspects of economy and society as well. The obvious reason for the said matter is that all people are in need of food and the complexity in providing the food for all countries including the developed countries and developing countries is in priority. The global challenge of the food security is something clear: By 2050, the world must feed about 9 billion people. The food demand is about 60% more than today. The United Nations Organization has determined and specified the end of hunger, accessing to the food security and the nutrition betterment and sustainable agriculture promotion as its second seventeen sustainable development goal for 2030 (World Economic Forum, 2016). Reasons for such challenge are as disclosed below:

(1) Population Growth: The population growth is remarkably different throughout the country and it is predicted that by 2050 the population of Africa may increase from 1 to 2 billion people. The population of developing countries has been increasingly urbanized and about 2.5 billion people of urbanization increase have been also anticipated in both Africa and Asian.

(2) *Tastes Changing:* Not only the population is now growing but also their diet is changing. The more individuals get richer, the more they use the foodstuffs

which are richer of the processed foods such as meat and dairy and the meat production mostly means more grain growth.

(3) *Climatic Changes:* Now about 40% of the earthly and terrestrial parts of the world in which we live are dry and the temperature increase has had a very great role in the process of desertification. With regards to the current situation and the amount of food which is now being produced, it can only feed a half of the said population by 2050.

(4) *Water Shortage:* The water shortage is another imminent crisis: About 28 % of the agriculture is in the water stress zones and we approximately need 1500 liters of water for producing one kilogram of wheat and we approximately need 16000 liters of water for producing one kilogram of meat. Therefore, in 2050 we will be in need for the double of this amount of water.

(5) *Farmers' Problem:* In the developed countries, less than 2 % of people deal with producing the crops and they breed the animals for the food purposes. A small number of these farmers have chosen the agriculture as an occupation. Meanwhile, the agricultural lands are being destroyed due to the dispersion and the agricultural soil is excessively eroded (World Resources Institute, 2013). The food security challenge is important in some parts of the world. The MENA is one of the foregoing regions. Countries of the MENA region (Namely the Middle East and North Africa which is a term applied for naming the major oil-producing countries located in the Middle East and North Africa. The limit of this region starts from Morocco in northwestern Africa and it extends to Iran that is the most eastern country of the Middle East region). The countries of the afore-said region are invariably relying on the foodstuffs imports in spite of earning the remarkable incomes arising out of the oil & gas exports that such

approach can endanger the food security in such countries more than ever and with regards to the global crises, prices increase and region's political crises. (Breisinger, et al., 2010) has used the food security concept in four subject matters and in order to identify the challenges of the MENA region. The said challenges are as follows: Economic and income growth, trade and infrastructures, agriculture, water, health and education. Results show that most of the old challenges of the said region are still standing and consequently taking an immediate action and measure will be assumed necessary in this region despite of such challenges and also the recent crisis of the foodstuffs throughout the world and the impacts of climatic changes on this crisis.

In addition to the climatic, economic variables and population growth and according to many of researchers (Paarlberg,1999; Bates, 2006; Bates and Block, 2013; Bates and Block, 2018) the institutional and political variables are of a very remarkable role in the economic development and growth and naturally in the betterment of the livelihood status and food security even the effects of such variables on the food security or directly or through the indirect economic canals may be more than other ones and therefore the quantification will obviously seem necessary especially in a region like the MENA which sounds it suffers from the institutional and political variables.

With regards to the significance of the food security problem in the MENA region and the existence of some worrisome climatic and economic conditions of the said region together with the institutional variables, this could become an incentive for us to perform a more accurate and authentic review on the afore-mentioned matter and in this study. In this study, we have dealt with surveying the relationship between the food security in the Middle East and North Africa (MENA) region for a period from

1995 to 2019 using the FMMs model. In addition to the economic and climatic variables applied in the former studies such as (Omidvar et al, 2019 and Bayar, 2019) so in such study, we have not dealt with the institutional variables in order to review the effects of institutional and political variables on the food security of the MENA region. Studying the interaction of each one of the indexes on the food security can be taken into consideration as an innovation applied in this essay and its difference with the other previous essays. In other words, in this essay, we have firstly estimated the economic index model and then in the subsequent models, we have respectively estimated and analyzed the natural resources indexes, climatic changes indexes, institutional indexes and finally the political indexes have been added to the said model and they are estimated and analyzed at each turn.

Results of this research show that in spite of the governments' endeavours for ensuring the food security the food crisis problem is still taken into account as a serious crisis throughout the said region (That the main reason of this problem is because of infirmity in the institutional variables in MENA countries which this infirmity includes: governance, prosperity, democracy and economic freedom) due to the failure of required participation and interaction among the public, private sectors and people. It should be noted that the existence of war and tensions in the region can be assumed as one of the other drastic coefficients on the food insecurity.

**Food Security in the MENA**

The Middle East and North Africa (MENA) enjoy an inharmonic structure in terms of economic development and food insecurity. The MENA region is one of the richest regions for the oil & gas reserves which provided about 4% of the global crude oil and 31% of the global liquefied natural gas in 2017 (BP, 2018). Nevertheless, this region is of the least tranquillity (Institute for Economics & Peace, 2018). The civil wars in Syria,

Iraq, Libya and Yemen have caused some damages to the physical capitals, human capitals and the production as well.

Furthermore, the pressures imposed on Qatar by Bahrain, Egypt, Saudi Arabia and the United Arab Emirates all have given rise to the instability in the foregoing region. Also, the political and economic instabilities, civil conflicts in the MENA countries and the price fluctuations of goods all are the most important menaces for developing the countries (Zolfaghari, et al., 2020). Despite such conditions, the countries like Algeria, Djibouti, Morocco and Oman have experienced some remarkable developments in the food security but in return some countries like Lebanon, Yemen and Jordan have incurred losses to their food security. Iraq has the highest level of the food insecurity almost always and due to the civil war increase. But Egypt, Iran, Israel, Saudi Arabia, Tunisia and the United Arab Emirates have retained their own reasonable food security from the MENA region (Bayar, 2019).

The trade exchanges of agricultural products for Iran is less than other countries of the said region due to the imposition of sanctions and these sanctions can hinder Iran from accessing to the global markets of foodstuffs (Zolfaghari and Hoseinzade, 2020).

The Middle East and North Africa (MENA) are one of the driest regions in the world with the annual regional average namely 1200 cubic meters per capita (The global average of nearly 7000). Water is now considered as a limiting coefficient for the betterment of agricultural products in the MENA region and not the land. Therefore, maximizing the water productivity and not the performance in the ground surface unit can be considered as a better strategy for the water management in the farm in such conditions. Water productivity increase needs an integral attention for improving the technical, agricultural and managerial actions. All MENA countries excluding Morocco are among the net importers of the agricultural products (World Bank, 2006). The

MENA region has an extreme temperature. It is predicted that such climatic changes will get worse in the subsequent decades. This region will experience some important challenges for its own improvement especially in the respectively agricultural, livelihood and food security sections by changing the raining patterns, water insecurity and the sea level predicted increase (Sieghart et al., 2018). The natural hazards can be taken into account as the detrimental and deleterious coefficients for the food security in the MENA region. The said region can be affected by the frequent drought events, water scarce or shortage, continuous and unsustainable methods of agriculture (Hameed et al., 2020).

The food security concept in the research literature means the people's accessibility to the sufficient, healthy and rich foodstuffs at any time and in each respect namely physically, socially and economically for satisfying their requirement to the food and the performed studies have generally shown that the main and principle reasons of the unprecedented challenge of the food insecurity in the MENA region include the population growth, urbanization growth, climatic changes, political and social unrests and conflicts (Political Instability), relying on importing the foodstuffs and being affected by the global price shocks. Some serious and worrisome implications arising out of the food security failure including the outbreak of various diseases and the poverty increase in the MENA region have been mentioned in these studies that such a thing may cause the intensification of tensions in the said region (Zolfaghari and Jariani, 2020). Accordingly, with regards to the coefficients affecting the food security which they have been mentioned in the related studies we can divide the above-said coefficients into four general groups as follows:

- *Economic Development Coefficients*: (GDP per capita growth, population growth, urbanization growth, military expenditures, Arab spring),

- *Natural Resources Coefficients:* (Water, Oil and Gas).

- *Climatic Changes Coefficients:* (Precipitation and Temperature).

- *Institutional Coefficients:* (Prosperity, Democracy, Economic Freedom, Governance and Corruption).

Any development often is defined with regards to the economic aspects thereof and also as the material prosperity increase through the employment and income for all the people in need. We must provide the qualified schools, healthy water for drinking and the social security for the development. The development causes the accessibility to the social services and ultimately the development causes the human improvement and the better quality of a material life through applying the more expanded options and opportunities that the people can realize their own potentials. Furthermore, the features of a more advanced economy will be provided by the development. These features are as follows: Equality of behaviour, right to protest (Voice & Accountability) and more responsibility and some opportunities for the vast civil participations. The Middle East and North Africa (MENA) have enjoyed the required potential for materializing the objectives of development and governance is one of those mechanisms that through which the comprehensive development can be provided for the people. The good governance in the MENA region like any other place almost shows itself at any occasion and at the time of interacting with the individuals and groups. The governments' and peoples' challenge throughout the region needs the improvement of better and effective interactions and minimizing the harmful and disappointing cases for moving towards the "good" governance. The good governance doesn't mean exerting the authority and power in the name of people. The good governance can be exerted by paying respect to the honesty, observing the peoples' rights and then meeting their requirements inside each country (World Bank, 2003).

Transparency about the important economic topics such as the public debt and liability and employment will be the main key of economic growth and strengthening the trust in the governments of the Middle East and North Africa (MENA). The largest part of the slow growth of the MENA is due to the failure in clarity. The MENA is the only region that has faced with a reduction in presenting the data clarity since 2005 (World Bank, 2020). The agricultural section enjoys a key role for the economic and social developments of the MENA region. Despite the sufficient potentials of the agricultural section in the MENA region the policy makers have not paid enough attention to it yet. Political tensions, instability, crises all have caused long unemployment (In compliance with the World Bank's statistics the rate of unemployment and job scarce in the MENA region was about 11% in 2017 while the rate of unemployment in the world was about 6%. Therefore, the unemployment in the MENA region in 2017 has been about 5% more than the global unemployment rate), remarkable insecurity and rural poverty. Notwithstanding the small share of the agricultural section in the gross domestic product, the agriculture has a strategic role for the sustainable development of the countries in the MENA region (FAO, 2018).

So, the economic development and the institutional coefficients are known as coefficients which are necessary to each other for accessing to the economic sustainable development, operating the natural resources in an appropriate and reasonable way, changing the agricultural procedures from the traditional procedure to the industrial one particularly due to the climatic changes and reduction of tensions in the direction of increasing the political stability and consequently the maximum increase of ensuring the food security in the MENA region.

Thus, with regards to the existing problems and crises in the MENA region, paying a special attention to the food security must be assumed as significant and

necessary affairs for ensuring the national and regional security and also creating the required backgrounds for the human development and economic sustainable development.

With regards to the indexes considered by this research, the average growth of these indexes will be taken into consideration by dividing the MENA region into high-income countries (Bahrain, Israel, Kuwait, Oman, Qatar, Saudi Arabia, The United Arab Emirates and Malta) and low-income countries (Iran, Iraq, Jordan, Lebanon, Syria, West Bank and Gaza strip, Yemen, Algeria, Djibouti, Egypt, Libya, Morocco and Tunisia) as disclosed below:

1. Cereal yield (Kilogram per hectare) which includes wheat, rice, barley, wild oat, rye, millet, sorghum, buckwheat, mixed seeds and the cultivation of cereals is different in the different countries and its cultivation rests on the economic development to some extent. The production depends on the soil nature, precipitation rate, irrigation, seed quality and techniques applied in the direction of growth (World Bank, 2020).

|  | 1995 (Average) | 2017 (Average) | Growth (Average) |
|---|---|---|---|
| MENA area | 2708.6 | 4779.6 | 76.0 |
| HIC[1] | 4426.3 | 8752.9 | 98.0 |
| LIC[2] | 1706.7 | 2251.2 | 31.9 |

2. GDP per capita growth (Annual %) and the annual growth rate of the gross domestic product per capita is based on the fixed rate of dollars of the United States of America (World Bank, 2020).

|  | 1995 (Average) | 2018 (Average) | Growth (Average) |
|---|---|---|---|
| MENA area | 1.28 | 0.29 | -0.99 |
| HIC | 2.06 | -0.09 | -2.15 |
| LIC | 0.85 | 0.56 | -0.29 |

3. Population growth (Annual %) is the annual growth rate of population per annum (World Bank, 2020).

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[1] HIC: High Income Countries

[2] LIC: Low Income Countries

|              | 1995 (Average) | 2018 (Average) | Growth (Average) |
|--------------|----------------|----------------|------------------|
| MENA area    | 2.47           | 1.96           | -0.51            |
| HIC          | 2.45           | 2.64           | 0.19             |
| LIC          | 2.61           | 1.50           | -1.11            |

4. Urban population growth means the population growth per annum and the people who live in the urban areas (World Bank, 2020).

|              | 1995 (Average) | 2018 (Average) | Growth (Average) |
|--------------|----------------|----------------|------------------|
| MENA area    | 3.01           | 2.38           | -0.63            |
| HIC          | 2.55           | 3.03           | 0.48             |
| LIC          | 2.06           | 3.26           | -1.20            |

5. Military expenditures (% of GDP) including the entire current costs and the armed forces' capital (World Bank, 2020).

|              | 1995 (Average) | 2018 (Average) | Growth (Average) |
|--------------|----------------|----------------|------------------|
| MENA area    | 5.84           | 4.09           | -1.76            |
| HIC          | 8.13           | 5.07           | -3.06            |
| LIC          | 4.47           | 3.35           | -1.12            |

6. People using at least basic drinking water services (% of population). This index includes the drinking water consumption from the piped water, protected dilled wells, protected springs and bottled water (World Bank, 2020).

|              | 2000 (Average) | 2017 (Average) | Growth (Average) |
|--------------|----------------|----------------|------------------|
| MENA area    | 88.74          | 94.30          | 5.56             |
| HIC          | 99.00          | 98.69          | -0.30            |
| LIC          | 84.38          | 92.12          | 7.74             |

7. Electricity production is done from oil, gas and coal sources (% of total) including the power sources, crude oil and oil products, natural gas, various types of coal and the derived fuels (World Bank, 2020).

|              | 1995 (Average) | 2015 (Average) | Growth (Average) |
|--------------|----------------|----------------|------------------|
| MENA area    | 94.73          | 93.32          | -1.41            |
| HIC          | 95.99          | 95.75          | -0.24            |
| LIC          | 93.82          | 91.55          | -2.27            |

8. Oil rents (% of GDP) are the difference between the crude oil production value with the global prices and the entire costs of production (World Bank, 2020).

|              | 1995 (Average) | 2017 (Average) | Growth (Average) |
|--------------|----------------|----------------|------------------|
| MENA area    | 15.97          | 11.06          | -4.21            |
| HIC          | 18.58          | 13.86          | -4.72            |
| LIC          | 12.85          | 9.19           | -3.67            |

9. Natural gas rents (% of GDP) or the natural gas rental is the difference between the natural gas production value with the global prices and the entire costs of production (World Bank, 2020).

|              | 1995 (Average) | 2017 (Average) | Growth (Average) |
|--------------|----------------|----------------|------------------|
| MENA area    | 0.37           | 0.74           | 0.38             |
| HIC          | 0.49           | 1.08           | 0.59             |
| LIC          | 0.25           | 0.51           | 0.26             |

10. Precipitation (Average Monthly Rainfall) is based on Millimeters (World Bank, 2020).

|              | 1995 (Average) | 2016 (Average) | Growth (Average) |
|--------------|----------------|----------------|------------------|
| MENA area    | 14.58          | 12.34          | -15.53           |
| HIC          | 14.14          | 8.48           | -40.03           |
| LIC          | 14.90          | 15.15          | 1.68             |

11. Temperature (Average Monthly Temperature) is based on Celsius.

|              | 1995 (Average) | 2016 (Average) | Growth (Average) |
|--------------|----------------|----------------|------------------|
| MENA area    | 20.27          | 23.62          | 16.51            |
| HIC          | 24.56          | 25.74          | 4.82             |
| LIC          | 21.18          | 22.08          | 4.23             |

12. The Legatum's Prosperity Index, 2019: According to Legatum's definition a prosperous society is a society which enjoys the efficient institutions, open economy, competent, healthy, educated and safe individuals. More points and privileges will be indicative of more prosperity.

|              | 2009 (Average) | 2019 (Average) | Growth (Average) |
|--------------|----------------|----------------|------------------|
| MENA area    | 52.98          | 53.43          | 0.45             |
| HIC          | 61.47          | 63.39          | 1.92             |
| LIC          | 47.58          | 47.10          | -0.48            |

13. Democracy Index: The democracy index will be computed based on five coefficients including the process of elections and pluralism, civil freedoms, government's performance, political participation and the political culture and each country can be included in one of the following classifications based on the existing results:

Hybrid, Authoritarian Regime (0-4), Regime (4-6), Flawed Democracy (6-8), Full Democracy (8-10), Economist Intelligence Unit (2019).

|  | 2006 (Average) | 2019 (Average) | Growth (Average) |
|---|---|---|---|
| MENA area | 3.74 | 3.65 | -2.42 |
| HIC | 4.02 | 4.15 | 3.26 |
| LIC | 3.56 | 3.33 | -6.38 |

14. Economic Freedom Index will be computed using twelve sub-indexes and in four groups of the rule of law, size of government, the efficiency of rules and the degree of market openness and there is a point between zero to hundred which is considered for each one of the sub-indexes and the average of gained points in such sub-indexes will be known as the final point of the index of economic freedom for each country. More points and privileges can be indicative of more index of economic freedom (2019).

|  | 1995 (Average) | 2019 (Average) | Growth (Average) |
|---|---|---|---|
| MENA area | 60.90 | 61.30 | 0.40 |
| HIC | 67.99 | 68.29 | 0.30 |
| LIC | 48.76 | 45.03 | -3.73 |

15. Voice and Accountability Index is one of the worldwide governance indexes (WGI) which is used for assessing the quality of the countries' governance and its domain starts from a weak governance (-2.5) up to a powerful governance (2.5). (The Worldwide Governance Indexes, 2019)

|  | 1996 (Average) | 2018 (Average) | Growth (Average) |
|---|---|---|---|
| MENA area | -0.67 | -0.90 | -34.33 |
| HIC | -0.24 | -0.60 | -150.00 |
| LIC | -0.89 | -1.05 | -17.98 |

16. Political Stability Index and Absence of Violence /Terrorism are one of the Worldwide Governance Indexes (WGI) which is used for assessing the quality of the countries' governance and its domain starts from a weak governance (-2.5) up to a powerful governance (2.5).

|  | 1996 (Average) | 2018 (Average) | Growth (Average) |
|---|---|---|---|
| MENA area | -0.36 | -0.85 | -136.11 |
| HIC | 0.17 | 0.08 | -52.94 |
| LIC | -0.63 | -1.32 | -109.52 |

17. Government Effectiveness Index is one of the worldwide governance indexes (WGI) which is used for assessing the quality of the countries' governance and its domain starts from a weak governance (-2.5) up to a powerful governance (2.5).

| | 1996 (Average) | 2018 (Average) | Growth (Average) |
|---|---|---|---|
| MENA area | -0.20 | -0.30 | -50 |
| HIC | 0.54 | 0.66 | 22.22 |
| LIC | -0.57 | -0.78 | -36.84 |

18. Regulatory quality index is one of the worldwide governance indexes (WGI) which is used for assessing the quality of the countries' governance and its domain starts from a weak governance (-2.5) up to a powerful governance (2.5).

| | 1996 (Average) | 2018 (Average) | Growth (Average) |
|---|---|---|---|
| MENA area | -0.28 | -0.34 | -21.43 |
| HIC | 0.57 | 0.63 | 10.53 |
| LIC | -0.71 | -0.82 | -15.49 |

19. Rule of Law Index is one of the Worldwide Governance Indexes (WGI) which is used for assessing the quality of the countries' governance and its domain starts from a weak governance (-2.5) up to a powerful governance (2.5).

| | 1996 (Average) | 2018 (Average) | Growth (Average) |
|---|---|---|---|
| MENA area | -0.21 | -0.31 | -47.62 |
| HIC | 0.44 | 0.62 | 40.91 |
| LIC | -0.53 | -0.77 | -45.28 |

20. Control of corruption index is one of the worldwide governance indexes (WGI) which is used for assessing the quality of the countries' governance and its domain starts from a weak governance (-2.5) up to a powerful governance (2.5).

| | 1996 | 2018 | Growth |
|---|---|---|---|
| MENA area | -0.23 | -0.34 | -47.83 |
| HIC | 0.35 | 0.45 | 28.57 |
| LIC | -0.52 | -0.74 | -42.31 |

21. Corruptions perception index (CPI) shows the corruption condition in the public sector of each country and according to this index, the countries are involved in the very clean (100) and highly corrupt (0) domains, transparency international, 2019.

|  | 2012 (Average) | 2019 (Average) | Growth (Average) |
|---|---|---|---|
| MENA area | 41.42 | 40.68 | -0.74 |
| HIC | 55.43 | 56.00 | 0.57 |
| LIC | 33.25 | 31.75 | -1.50 |

Accordingly, the above-mentioned information shows that:

- The low- income countries have enjoyed a food production growth (Food Security) about ⅓ of the high-income ones. The negative growth of GDP in the low- income countries was about ⅐ of the negative growth of such index in the high-income countries while the population growth in the low-income countries has reduced for 1 per cent and increased for 2 per cent in the high-income ones. Also, the urbanization growth in the low-income countries has decreased for 1 per cent and this has increased in the high-income ones for less than 1 per cent. The military expenditures have decreased in both groups that the reduction of such costs and expenditures in the low-income countries has been about ⅓ of the high-income ones. The per cent of population that is using the minimum initial services of drinking water in the low-income countries had a positive growth of 10 per cent but it became less than 1 per cent in the high-income countries. The power (Electricity) production decrease in the low-income countries was more than double of such reduction in the high-income countries. The oil rents have decreased in both groups namely the low-income countries about 4 per cent and the high-income countries about 5 per cent but in return, the natural gas rents in both groups were less than 1 per cent (Zolfaghari and Sahabi, 2019).

- The average growth of precipitation in the low-income countries has increased for 2 per cent but it has decreased for 40 per cent in the high-income ones.

- The average growth of Legatum's prosperity index has reduced in the low-income countries for less than 1 per cent but this has faced with increase for 2

per cent in the high-income ones. The democracy index average shows that both groups of the said countries are included in the authoritarian regime. The high-income countries are of the economic freedom for 1 per cent more than the low-income ones. Concerning the worldwide governance index, the sub-index of the objection and accountability is weak (Negative) in both groups of the said countries but the sub-indexes related to the political stability, government effectiveness, regulatory quality, rule of law and the control of corruption are positive in the high-income countries but the foregoing sub-indexes are negative in the low-income ones. The corruptions perception index (CPI) in the high-income countries has faced with betterment but the said index has reduced in the low-income countries.

**Former Studies**

Paying attention to the foodstuffs preparation and food security is of a great importance with regards to the continuous population increase, urbanization growth, global crises and regional crises. In this part, we will deal with some studies which have been performed regarding the food security preparation in the MENA region and other regions.

1. *FAO (2017):* The FAO has applied the food insecurity experience scale (FIES) in its assessment of the food security condition in the MENA region and has shown that the prevalence of severe food insecurity among the adult population of the Middle East and North Africa between 2014 and 2015 was nearly 9.5 per cent which meant endangering the food security of approximately 30 million people in the said region. Such assessment shows that in the last five years the food security level in the MENA region has severely decreased and this matter has caused that the progressive developments (which were realized after 2010 and then had led to the reduction of malnutrition prevalence, growth retardation, anemia and destitution) would practically fade out. Also, the MENA region is now facing with some unprecedented challenges regarding the food security due to the various risks arising out of the conflicts, water shortage and climatic changes.

2. *World bank (2008):* The world bank in its research titled the food crisis in the Middle East and North Africa has come to this conclusion that the countries of this region are affected by the global food crisis because these countries are among the great foodstuff importers and they must rely on the imports for providing about 50% of their own food requirements. The net foodstuffs imports involve about 5 to 10 per cent of the entire imports in most MENA countries that the wheat is of the maximum share among them. Persian Gulf countries despite utilizing the oil income provide about 100% of their own main dish through the imports. In most countries, the prices increase may impose a heavy financial burden to the governments other than creating the social and political unrests and disquiets. Probably, the foodstuffs price increase in the short run may cause the poverty increase in the urban areas and the villagers lose their own agricultural lands in the urban areas.

3. *The Middle East and North Africa:*

Bayar (2019) studying the role of the globalization process in performing a slight improvement of nutrition and hunger relief through the insecurity reduction in the Middle East and North Africa between 1999 – 2015 using the co-integration test and casualty test, Westerland and Edgerton (2007) and Dumitrescu and Hurlin (2012) for analyzing the short-term and long-term effects of the different types of globalization on the food insecurity all have come to this conclusion that the trade globalization, financial globalization, social globalization and political globalization may cause the food insecurity.

For assessing and comparing the food security and social using the weighted data from the 2016 Gallup World Poll (GWP) and then classifying the countries based on the moderate to the severe prevalence of food insecurity, gross domestic product and political stability to three main groups, Omidvar et al. (2019) came to this conclusion that the gained results were an approach of the MENA countries diversity and the different options can provide them with the necessary policy for improving their food security.

4. *Other Countries:*

Dithmer and Abdulai (2017) have studied the effects of trade openness and other coefficients on the food security which are measured by the diet energy using the reciprocal data of 151 countries and GMM method in the time interval of 1980 – 2007. Results of such study have shown that the trade openness and economic growth can put some positive and significant effects the energy consumption in the diet and also such effects can help the various developments of the dietary diversity.

With the aim of studying the effects of climatic changes on the food security in the provinces like Saguday and Quirino of the Philippines during 2010 – 2011 using the risk assessment method and modeling for developing the food security Carandang et al. (2015) understood that the role of local public sector departments can be very important in managing the natural hazards crisis including the flood for benefiting from it in the agriculture and preparing the food security.

Bezuneh and Yiheyis (2014) have applied for doing an experimental study in their researches for the effects of trade liberalization on the foodstuffs accessibility in the developing countries using the panel data provided by 37 developing countries and the alternative estimation methods in the time interval between 2010 – 2012 and they understood that the trade liberalization within a short time can put a negative impacts on the foodstuffs accessibility in the target countries.

The result of a slight delay is positive and the sum of two different results is not ensued from it. Therefore, the mid and long term effect of the trade liberalization is realized on condition that the favourable foodstuffs can be accessible.

With the aim of reviewing the effects of trade liberalization on the food security in China and Sri Lanka and using the multiple regression method of the time series during 1980 - 2009, Herath (2014) has shown that the trade liberalization has not had a very outstanding effect on the food security of China but its effect on the food security

of Sri Lanka has been negative. The key variable of the rate of gross domestic product puts a remarkable effect on the food security of both countries and also it has put a good positive effect on the food security of the period under review. Changes in the imported foodstuffs price has been a key and impressive point in ensuring the food security in Sri Lanka but it was not considered as an important coefficient on ensuring the food security of China.

With the aim of performing a comprehensive analysis concerning the effect of climatic variables, technology and products price on the performance of respectively corn, soya beans and wheat in the United States of America and using the data of 1977-2007 and instrument variable regression methods and GMM, Huang and Khanna (2010) came to this conclusion that an increase in the global temperature will remarkably reduce the corn, soya beans and wheat yield. Changes in the precipitation will put clear effects on the corn and soya beans performance.

Using the coefficients affecting the food security and per capita income of the residents of rural communities, foodstuffs retailing index, agricultural natural hazards in the target region, planting and saving rates of the residents of cities and villages and also using POLS, FE (Fixed effects), DIF-GMM (GMM Difference) and SYS-GMM (GMM System) for evaluating the relationship between the entire variables all showed that the climatic changes in the considered year are remarkably effective on the food security of China but in return the price of foodstuffs had left no influence on the food security of China in the same year.

With regards to the flood which happened in 1998 and caused a severe loss and damage to the main products out of rice and then threatened about ten million people's lives, Del Ninno et al. (2003), in their research applied for studying the rile of interventions of government's policy making in the direction of fixing the rice markets

at the time of occurring the torrent and flood including the trade liberalization at the beginning of 1990. In this study and using the sum of panel data which included 750 households at three periods (Each period lasts for 13 months) and the fixed effects estimation, they came to this conclusion that the flood in Bangladesh has a very key role in the process of the private sector's appropriate investment and the government's policies can help to retain the food accessibility and in a limited form and to increase the price and the family's rate of accessibility to the foodstuffs. In the short, mid and long run, the need to prevent the food insecurity crisis appearance will be necessary due to the population increase. Governments in the developing countries are now restricted for preventing the detrimental impacts arising out of the food insecurity and also the poverty reduction. The decrease of the negative impact of the natural hazards needs the execution of the effective policies and increasing the required sources for the poverty reduction and malnutrition both at the time of disaster occurrence and in the long run.

Studying the performed studies concerning the food security shows that the reduction in the food security level in the region has lead to the outbreak of different diseases and an increase in the regional tensions. Also, the foodstuffs price increase has followed by the poverty and unemployment increase. Concentrating the recommended tactics and strategies in such studies which are used for ensuring the food security is as disclosed below: Betterment of relationships and political stability, trade openness and the government's performance improvement in managing the natural hazards crisis.

Focusing of such researches has been normally on the effect of the economic, political and climatic variables but slight or marginal attention has been paid to the social variables whereas the importance of civil and social participations for establishing the food security in the developing countries including the MENA region are among the determining and crucial coefficients together with the population growth,

urbanization growth and the appearance of regional and international crises. Accordingly and with regards to the problems and crises existing in the MENA region, our special attention to the food security in order to ensure the national and regional security and also creating the required backgrounds for human development and the economic sustainable development will be of great importance and as an urgent need for filling the gap of such significant matter in the literature of food security studies.

## Experimental Model and Approach

Wang (2010) in his research for studying the effective coefficients in the food security in China has applied some methods like the FE, POLS (Fixed Effects), DIF-GMM (GMM Difference) and SYS-GMM (GMM System) and used the following equation:

$$lny_{it} = \delta lny_{it-1} + X'_{it}\beta + \alpha_i + \varepsilon_{it} \quad , \quad \varepsilon_{it}\epsilon N(0.\delta_\varepsilon^2) \tag{1}$$

That in compliance with this equation $y_{it}$: Food consumption, $X'_{it}$: A set of the explanatory and effective variables on the food consumption, $\alpha_i$: Fixed effects, δ and β: the estimated coefficients and $\varepsilon_{it}$: Random disturbance.

In this study we have used the finite mixture models (FMMS) as a widely used tool for modeling the multimodal data, skewed or asymmetrical data for estimating the relation (1). In this method it is assumed that the observed data belong to the unobserved subpopulations called classes and the mixture of probability densities or regression models. The main concept in the limited mixture modeling is that the observed data consist of the different but unobserved subpopulations (Diagram 1). The observed distribution is approximately normal together with a slight asymmetry and the reason for this matter is that such a normal distribution is a mixture of two normal densities.
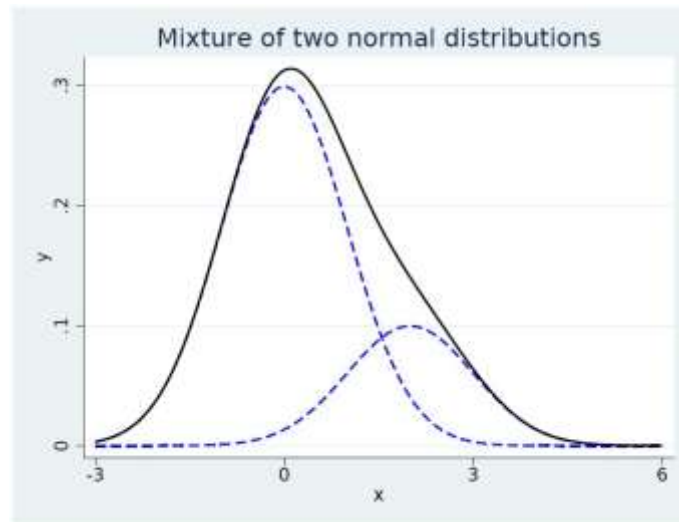
Diagram 1

Generally speaking, FMMs can provide us with modeling for a mixture of the subpopulations and with each kind of distribution so there is not any necessity for creating a normal distribution for the target subpopulation. This method allows us to estimate the mixtures of linear and generalized linear regression models. Also, the inference possibility exists for each subpopulation and therefore we can categorize our individual observations into one subgroup.

Such a method is widely used for the different backgrounds and for classifying observations, to adjust for clustering and to model unobserved heterogeneity due to the flexibility of FMMs. The mixtures of normal densities with equal variances for estimating each target invariable distribution has caused that FMMs could change into a favourable tool for modeling the multimodal, skewed or asymmetrical data.

FMMs are the probable models which combine about two or more density functions. In such a method it is assumed that the observed responses of y are resulted from the different and distinct classes of g $\left( f_1. f_2 \cdots . f_g \right)$ in proportions $\pi_1. \pi_2 \cdots . \pi_g$. The simple model of the density of a model of mixtures includes g component and as disclosed below:

$$f(y) = \sum_{i=1}^{g} \pi_i \, f_i(y|x'\beta_i) \qquad (2)$$

That in it $\pi_i$ of the i class $0 \le \pi_i \le 1$ , $\sum \pi_i = 1$ and $f_i(\cdot)$ the conditional probability

density function for the observed response in the ith class model. FMM applies the

multimodal logistic distribution to model the probabilities for the latent classes. The

latent class probability for i can be as disclosed below:

$$\pi_i = \frac{exp(\gamma_i)}{\sum_{j=1}^{g} exp(\gamma_j)} \qquad (3)$$

That in it $\gamma_i$ is a linear prediction for the latent class of i and in a default form we can

say that the first latent class of basic level includes $\gamma_{1=0}$ and $exp(\gamma_1) = 1$, therefore, the

likelihood is computed as the sum of the probability-weighted conditional likelihood

from each latent class.

## Model Data and Variables

According to the classifications done by the world bank, the countries of the Middle

East and North Africa other than the high-income countries (World Bank: For the

current 2020 fiscal year, low-income economies are defined as those with GNI per

capita) consist of 14 Asian countries including Iran, Iraq, Jordan, Lebanon, Syria, West

Bank, Gaza Strip and Yemen and 7 African countries including Algeria, Djibouti,

Egypt, Libya, Morocco and Tunisia. In spite of this matter that the countries of the said

region have the main oil and gas resources of the world but they have some different

economic, social and environmental features and characteristics. This research has been

completed within the time interval of 1995-2019 and therefore the variables and data of

this model (Separately and based on the economic indexes, social indexes, climatic

changes indexes and the natural resources indexes) are as disclosed below:

| Variables: | Symbols: | Sources; |
|---|---|---|
| Dependent variable: | foodsecur | WDI |
| Cereal yield (kg per hectare): | | |
| Independent variables: | | |
| (1) Economic Indicators: | | |
| - GDP per capita growth (annual %) | gdpcg | WDI |
| - Population growth (annual %) | popg | WDI |
| - Urban population growth (annual %) | upg | WDI |
| - Military expenditure (% of GDP) | mex | WDI |
| - Arab Spring | arab | - |
| (2) National Resources Indicators: | | |
| - People using at least basic drinking water services (% of population) | dw | WDI |
| - Electricity production from oil, gas and coal sources (% of total) | ep | WDI |
| - Oil rents (% of GDP) | oiler | WDI |
| - Natural gas rents (% of GDP) | ngre | WDI |
| (3) Climate Change Indicators: | | |
| - Average monthly precipitation (mm) | amp | WDI |
| - Average monthly Temperature (Celsius) | amt | WDI |
| (4) Institutional variables | | |
| - Legatum prosperity index | lega | Legatum Institute |
| - Democracy index | democ | Economist Intelligence Unit |
| - Index of economic freedom | iofe | Heritage |

## Studying and Reviewing the Model Variables Correlation

We use the correlation coefficient and covariance for studying the relation between dependent and independent variables. If the amount of such coefficient is positive so the relation between two variables will become direct and if it is negative therefore for performing changes those two variables will remain opposite each other. Also, the following domains will be used for determining the correlation domain of the relations existing between the variables:

- Correlation domain 0.20 to 0.35: Significant and relatively weak relation.

- Correlation domain 0.35 to 0.65: Significant and higher than one per cent level.

- Correlation domain 0.65 to 0.85: sufficiently accurate.

- Correlations higher than 0.85: The close relation of two variables.

In the table (1) the results of correlation coefficient and covariance between the dependent variable (Food Security) and independent variables (Economic indexes,

natural resources, climatic changes indexes and institutional indexes) have been shown. With regards to the foregoing explanations, the conclusion arising out of these results show that the correlation coefficient of the following indexes are significant and they are of relation with the food security variable:

- Energy production, monthly average precipitation, monthly average temperature, relatively weak relation,

- Military expenditures, a per cent of the population that use the minimum initial services of drinking water, objection and accountability, political stability index, government efficiency, regulatory quality and control of corruption,

- All the above-said correlation coefficients are negative and show that they are of an inverse relationship with the food security variable except an index of a per cent of population that uses the minimum initial services of drinking water and monthly average temperature.

Table (1): Correlation coefficient between the dependent variable and the model independent variables

|  | foodse~r | gdpcg | popg | upg | mex | arabs | dw | ep | oilre | ngre | amp | amt |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| foodsecur | 1.0000 | | | | | | | | | | | |
| gdpcg | -0.0956 | 1.0000 | | | | | | | | | | |
| popg | 0.0909 | -0.2277 | 1.0000 | | | | | | | | | |
| upg | -0.0977 | -0.2381 | 0.9613 | 1.0000 | | | | | | | | |
| mex | -0.4812 | -0.0353 | 0.4109 | 0.5057 | 1.0000 | | | | | | | |
| arabs | 0.0086 | 0.0008 | -0.0056 | -0.0389 | 0.0317 | 1.0000 | | | | | | |
| dw | 0.3860 | -0.0041 | 0.1986 | 0.0792 | -0.1427 | 0.1179 | 1.0000 | | | | | |
| ep | -0.2917 | 0.0741 | 0.2700 | 0.2682 | 0.4642 | 0.0684 | 0.5411 | 1.0000 | | | | |
| oilre | -0.1325 | 0.6036 | -0.3150 | -0.2485 | 0.0046 | -0.0082 | 0.1263 | 0.2774 | 1.0000 | | | |
| ngre | -0.0061 | 0.0441 | -0.2592 | -0.1809 | 0.0355 | 0.0200 | 0.1571 | 0.2349 | 0.7758 | 1.0000 | | |
| amp | -0.2484 | -0.1649 | 0.1343 | 0.1116 | 0.1242 | 0.0113 | -0.5170 | -0.1909 | -0.4000 | -0.4625 | 1.0000 | |
| amt | 0.3284 | 0.1647 | -0.1924 | -0.2103 | -0.1353 | -0.1019 | 0.4005 | 0.2022 | 0.3770 | 0.4900 | -0.7691 | 1.0000 |
| lega | -0.0898 | 0.2074 | 0.1613 | 0.1466 | 0.0062 | -0.1142 | 0.4183 | 0.4674 | 0.2606 | 0.1268 | -0.2250 | 0.0357 |
| democ | -0.1893 | 0.0801 | 0.0766 | 0.0129 | 0.0120 | 0.1373 | -0.1134 | 0.1150 | -0.3516 | -0.4569 | 0.3945 | -0.0700 |
| iofe | -0.1838 | -0.2795 | 0.1824 | 0.1745 | -0.1160 | -0.0392 | -0.1249 | -0.1093 | -0.7166 | -0.6803 | 0.2092 | -0.1509 |
| voac | -0.3078 | -0.0563 | 0.0874 | 0.0571 | 0.0875 | 0.1594 | -0.1711 | 0.0912 | -0.4732 | -0.5218 | 0.4535 | -0.1579 |
| pos | -0.4765 | -0.1164 | -0.1188 | 0.0196 | 0.0461 | -0.0885 | -0.2583 | -0.1874 | -0.3033 | -0.2763 | -0.1555 | -0.0480 |
| goef | -0.4785 | -0.4428 | 0.1527 | 0.2323 | 0.0773 | -0.1253 | -0.1462 | -0.0068 | -0.6033 | -0.4806 | 0.1758 | -0.3584 |
| requ | -0.0475 | -0.2748 | 0.4215 | 0.3716 | -0.1361 | -0.0896 | -0.1403 | | -0.8279 | -0.8119 | 0.3551 | -0.3468 |
| rula | -0.1655 | -0.2027 | 0.1864 | 0.2156 | -0.0606 | -0.0836 | 0.0944 | -0.0545 | -0.6031 | -0.5935 | -0.1054 | -0.0120 |
| coco | -0.3059 | -0.2745 | 0.0635 | 0.1247 | -0.0372 | 0.0226 | 0.1136 | 0.0272 | -0.4569 | -0.3385 | -0.2504 | 0.1114 |
| cpi | -0.1014 | -0.0725 | -0.0077 | -0.0369 | 0.0640 | 0.5956 | 0.2115 | 0.0801 | -0.2504 | -0.1950 | -0.1376 | 0.0482 |

|  | lega | democ | iofe | voac | pos | goef | requ | rula | coco | cpi |
|---|---|---|---|---|---|---|---|---|---|---|
| lega | 1.0000 | | | | | | | | | |
| democ | -0.1940 | 1.0000 | | | | | | | | |
| iofe | -0.1181 | 0.6385 | 1.0000 | | | | | | | |
| voac | -0.2577 | 0.9467 | 0.7301 | 1.0000 | | | | | | |
| pos | 0.1175 | -0.0368 | 0.5042 | 0.0993 | 1.0000 | | | | | |
| goef | 0.1089 | 0.1977 | 0.7226 | 0.3512 | 0.7669 | 1.0000 | | | | |
| requ | -0.0291 | 0.4856 | 0.8295 | 0.5650 | 0.4370 | 0.6532 | 1.0000 | | | |
| rula | 0.0901 | 0.3240 | 0.8501 | 0.4326 | 0.7235 | 0.7688 | 0.7684 | 1.0000 | | |
| coco | 0.1091 | 0.2346 | 0.7368 | 0.3610 | 0.7795 | 0.7692 | 0.5703 | 0.8780 | 1.0000 | |
| cpi | -0.1849 | 0.2045 | 0.2580 | 0.3051 | 0.2085 | 0.1832 | 0.1454 | 0.2755 | 0.4227 | 1.0000 |

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**Model Estimation Result**

The unit root test was done using the Fisher Type Unit Root Test prior to the model estimation and for ensuring the target data durability. The test results showed that the whole data are in the durability level.

Table (2):  Results of Data Unit Root

| Variables | Result | Variables | Result |
|---|---|---|---|
| Foodsecur | 0.0000* | amt | 0.0000* |
| Gdpcg | 0.0000* | lega | 0.0000* |
| Popg | 0.0000* | democ | 0.0000* |
| Upg | 0.0000* | Iofe | 0.0000* |
| Mex | 0.0348* | voac | 0.0000* |
| Arab | 0.0833** | Pos | 0.0000* |
| Dw | 0.0000* | goef | 0.0000* |
| Ep | 0.0707** | requ | 0.0000* |
| Oiler | 0.0000* | Rula | 0.0000* |
| Ngre | 0.0000* | coco | 0.0000* |
| Amp | 0.0000* | copi | 0.0047* |

Notes: $p < 0.05$, $p < 0.1$

Models of this study are divided into three classes:

(1)  Model of economic indexes

(2)  Model of economic indexes and natural resources

(3)  Model of economic indexes, natural resources and climatic changes

(4)  Model of economic indexes and natural resources, climatic changes and the interaction of GDP per capita growth and each one of the institutional indexes: Legatum's prosperity, democracy, economic freedom, governance indexes (Objection and accountability, political stability, governments' efficiency, regulatory quality, rule of law, control of corruption) and corruptions perception index (CPI).

Each one of the foregoing models has been estimated using the Finite Mixture Models (FMMs) that the results have been stated in the following tables:

Table (3): Results of Estimating the Model of Economic Indexes

| Variables | gdpcg | Popg | Upg | mex | Arabs |
|---|---|---|---|---|---|
| Results | -2.60* (0.009) | 8.32* (0.000) | -8.06* (0.000) | -4.41* (0.000) | 0.42 (0.677) |
| Variables | cons | | | | |
| Results | 10.21 (0.000) | *p<0.05, **p<0.01 | | | |

Table (4): Results of Estimating the Model of Economic Indexes and Natural Resources

| Variables | Gdpcg | Popg | Upg | mex | Arabs |
|---|---|---|---|---|---|
| Results | 1.69** (0.091) | 7.08* (0.000) | -6.83* (0.000) | -3.00* (0.003) | -1.36 (0.174 ) |
| Variables | Dw | Ep | Oilre | ngre | Cons |
| Results | -2.09* (0.037) | -4.82* (0.000) | -7.17* (0.000) | 5.93* (0.000) | 6.66 (0.000) |

*p<0.05  **p<0.01

Table (5): Results of Estimating the Model of Economic Indexes, Natural Resources

and Climate changes

| Variables | Gdpcg | Popg | Upg | Mex | Arabs |
|---|---|---|---|---|---|
| Results | 1.79** (0.073) | 7.28* (0.000) | -6.84* (0.000) | -2.81* (0.005) | -1.82** (0.069) |
| Variables | Dw | Ep | Oilre | Ngre | Amp |
| Results | -1.70** (0.089) | -4.65* (0.000) | -8.31* (0.000) | 4.86* (0.000) | -2.24* (0.025) |
| Variables | Amt | Cons | | | |
| Results | 2.12* (0.034) | 2.67 (0.007) | *p<0.05  **p<0.01 | | |

Table (6): Results of Estimating the Model of Economic Indexes, Natural Resources,

Climate Changes and the Interaction of Legatum's Prosperity and GDP per capita

growth

| Variables | Glega | Popg | Upg | Mex | Arabs |
|---|---|---|---|---|---|
| Results | 1.22 (0.223) | 6.25* (0.000) | -5.91* (0.000) | -2.40* (0.016) | -0.97 (0.334) |
| Variables | Dw | Ep | Oilre | Ngre | Amp |
| Results | -2.64 (0.008)* | -3.05 (0.002)* | -7.09 (0.000)* | 5.23 (0.000)* | -2.30 (0.022)* |
| Variables | Amt | Cons | | | |
| Results | 0.50 (0.617) | 3.30* (0.001) | *p<0.05  **p<0.01 | | |

Table (7): Results of Estimating the Model of Economic Indexes, Natural Resources, Climate Changes and the Interaction of Democracy and GDP per capita growth

| Variables | gdemoc | Popg | Upg | Mex | Arabs |
|---|---|---|---|---|---|
| Results | 1.33 (0.185) | 7.05* (0.000) | -6.80* (0.000) | -2.70* (0.007) | -2.06* (0.040) |
| Variables | Dw | Ep | Oilre | Ngre | Amp |
| Results | -3.14* (0.002) | -4.11* (0.000) | -9.27* (0.000) | 5.48* (0.000) | -2.71* (0.007) |
| Variables | amt | Cons | | | |
| Results | 0.09 (0.930) | 4.25* (0.000) | *p<0.05  **p<0.01 | | |

Table (8): Results of Estimating the Model of Economic Indexes, Natural Resources, Climate Changes and the Interaction of Economic Freedom and GDP per capita growth

| Variables | giofe | Popg | Upg | Mex | Arabs |
|---|---|---|---|---|---|
| Results | 2.74* (0.006) | 9.93* (0.000) | -9.08* (0.000) | -4.39* (0.000) | -2.85* (0.004) |
| Variables | Dw | Ep | Oilre | ngre | Amp |
| Results | 6.37* (0.000) | -11.50* (0.000) | -10.41* (0.000) | 7.04* (0.000) | -2.06* (0.040) |
| Variables | Amt | Cons | | | |
| Results | 1.61 (0.108) | 7.98* (0.000) | *p<0.05  **p<0.01 | | |

Table (9): Results of Estimating the Model of Economic Indexes, Natural Resources, Climate Changes and the Interaction of Objection and Accountability and GDP per capita growth

| Variables | gvoac | Popg | Upg | Mex | Arabs |
|---|---|---|---|---|---|
| Results | -2.27* (0.023) | 7.27* (0.000) | -6.89* (0.000) | -2.58* (0.010) | -1.93* (0.054) |
| Variables | dw | Ep | Oilre | ngre | Amp |
| Results | -1.93** (0.054) | -4.62* (0.000) | -8.33* (0.000) | 5.08* (0.000) | -2.44* (0.015) |
| Variables | amt | Cons | | | |
| Results | 1.85** (0.064) | 2.84* (0.005) | *p<0.05  **p<0.01 | | |

Table (10): Results of Estimating the Model of Economic Indexes, Natural Resources, Climate Changes and the Interaction of Political Stability and GDP per capita growth

| Variables | gpos | Popg | Upg | Mex | Arabs |
|---|---|---|---|---|---|
| Results | -2.00* (0.045) | 7.26* (0.000) | -6.89* (0.000) | -2.69* (0.007) | -1.95* (0.051) |
| Variables | dw | Ep | Oilre | Ngre | Amp |
| Results | -1.90** (0.058) | -4.55* (0.000) | -8.40* (0.000) | 5.06* (0.000) | -2.45* (0.014) |
| Variables | amt | Cons | | | |
| Results | 1.84** (0.066) | 2.81* (0.005) | *p<0.05  **p<0.01 | | |

Table (11): Results of Estimating the Model of Economic Indexes, Natural Resources, Climate Changes and the Interaction of Government's Efficiency and GDP per capita growth

| Variables | ggoef | Popg | Upg | Mex | Arabs |
|---|---|---|---|---|---|
| Results | -1.90** (0.057) | 7. 26* (0.000) | -6.89* (0.000) | -2.71* (0.007) | -1.96* (0.049) |
| Variables | dw | Ep | Oilre | ngre | Amp |
| Results | -1.89 (0.059)** | -4.50 (0.000)* | -8.27 (0.000)* | 5.04 (0.000)* | -2.43 (0.015)* |
| Variables | amt | Cons | *p<0.05 **p<0.01 | | |
| Results | 1.85** (0.064) | 2.80* (0.005) | | | |

Table (12): Results of Estimating the Model of Economic Indexes, Natural Resources, Climate Changes and the Interaction of Regulatory Quality and GDP per capita growth

| Variables | Grequ | Popg | Upg | Mex | Arabs |
|---|---|---|---|---|---|
| Results | -2.16* (0.031) | 7.27* (0.000) | -6.89* (0.000) | -2.64* (0.008) | -1.98* (0.048) |
| Variables | dw | Ep | Oilre | ngre | Amp |
| Results | -1.90** (0.057) | -4.53* (0.000) | -8.32* (0.000) | 5.07* (0.000) | -2.43* (0.015) |
| Variables | amt | Cons | *p<0.05 **p<0.01 | | |
| Results | 1.87** (0.062) | 2.81* (0.005) | | | |

Table (13): Results of Estimating the Model of Economic Indexes, Natural Resources, Climate Changes and the Interaction of Rule of Law and GDP per capita growth

| Variables | Grula | Popg | Upg | Mex | Arabs |
|---|---|---|---|---|---|
| Results | -1.69** (0.091) | 7.26* (0.000) | -6.89* (0.000) | -2.70* (0.007) | -1.96** (0.050) |
| Variables | dw | Ep | Oilre | ngre | Amp |
| Results | -1.89** (0.059) | -4.49* (0.000) | -8.27* (0.000) | 5.02* (0.000) | -2.44* (0.015) |
| Variables | amt | Cons | *p<0.05  **p<0.01 | | |
| Results | 1.85** (0.064) | 2.80* (0.005) | | | |

Table (14): Results of Estimating the Model of Economic Indexes, Natural Resources, Climate Changes and the Interaction of Control of Corruption and GDP per capita growth

| Variables | gcoco | Popg | Upg | Mex | Arabs |
|---|---|---|---|---|---|
| Results | -1.86** (0.063) | 7.26* (0.000) | -6.89* (0.000) | -2.71* (0.007) | -1.96** (0.050) |
| Variables | dw | Ep | Oilre | Ngre | Amp |
| Results | -1.89** (0.059) | -4.50* (0.000) | -8.31* (0.000) | 5.04* (0.000) | -2.44* (0.015) |
| Variables | amt | Cons | *p<0.05  **p<0.01 | | |
| Results | 1.85** (0.064) | 2.80* (0.005) | | | |

Table (15): Results of Estimating the Model of Economic Indexes, Natural Resources, Climate Changes and the Interaction of Corruptions Perception and GDP per capita growth

| Variables | gcpi | Popg | Upg | Mex | Arabs |
|---|---|---|---|---|---|
| Results | 2.43* (0.015) | 7.53* (0.000) | -7.23* (0.000) | -2.62* (0.009) | -2.27* (0.023) |
| Variables | dw | Ep | Oilre | Ngre | Amp |
| Results | -2.79* (0.005) | -4.33* (0.000) | -9.09* (0.000) | 5.82* (0.000) | -2.94* (0.003) |
| Variables | amt | Cons | *p<0.05  **p<0.01 | | |
| Results | 1.22 (0.223) | 3.69** (0.000) | | | |

Conclusion of estimating the factors which can put effects on the food security in the MENA region are as disclosed below:

- *GDP per capita growth*: The GDP per capita growth in the model of economic indexes with the negative effects and in the presence of variables related to the natural resources and climatic changes can have a positive effect on the food security. The interaction of GDP per capita growth and economic freedom index and also the interaction of GDP per capita growth and corruptions perception index will have a positive effect on the food security. Such positive effect on the food production due to understanding the food crisis and the necessity of obtaining and executing the required strategies for working out a solution for this problem must be undertaken by the governments of the MENA region that this matter can be beneficial for the stability and profitability in the long run (World Bank, 2017). But in return, we see that the interaction of GDP per capita growth with one of the sub-indexes of governance (Objection and accountability, political stability, government's efficiency, regulatory quality, rule of law and control of corruption) all have a negative effect on the food security. Meanwhile, the interaction of GDP per capita growth and Legatum's prosperity index and also the interaction of GDP per capita growth and

democracy index have not any significant effect on the food security. Such negative effect and the failure of existing a significant effect shows that the structural and institutional problems have been spread throughout the said region (Bates and Block, 2018; Heritage, 2017; Bates and Block, 2013; Bates 2006; Paarlberg, 1999).

- *Population growth* in the entire models will have a very positive effect on the food security which is indicative of its direct effect on the livelihood status and food security especially in a region like the MENA that is suffering from the lack of institutional and political variables (Bates and Block, 2018; Bates and Block, 2013; Bates 2006; Paarlberg, 1999).

- *Urbanization growth*: The urbanization growth in the entire models has a negative effect on the food security. In other words, the villagers' immigration from the rural communities to the cities particularly the big cities have led to the reduction of manpower in the agricultural section and exerting the compression and high pressure on the urban areas has led to more insecurity in the MENA region which is one of the challenges of food security of the said region (World Resources Institute, 2013).

- *Military expenditures:* The military expenditures of the entire models have a negative effect on the food security. The civil wars in some of the MENA countries (Syria, Libya and Yemen) that are known as a very serious menace for the said region's security in the years to come (World Bank 2008, Bayar 2019) have changed this region into a military region and the countries have allocated a remarkable budget of their own income to purchase the military equipments that this matter puts some negative effects on the food production in these

countries (World Bank 2008; Institute of Economics & Peace 2 018; Legatum's Prosperity Index 2019; Bayar, 2019).

- *Arab spring*: The Arab spring in the model of economic indexes, the model of economic indexes and natural resources and the model of interaction of GDP per capita growth and Legatum's Prosperity Index have no significant effect of the food security but they have a significant effect on the food security in the other variables. In the other words, the presence of institutional indexes in the said model causes an inverse effectiveness of Arab Spring on the food security which this is indicative of the weakness of institutional variables in the MENA region (Bates and Block, 2018; Bates and Block, 2013; Bates, 2006; Paarlberg, 1999).

- *Water consumption:* The water consumption in the model of GDP per capita growth and Legatum's Prosperity Index have not any significant effect on the food security but the water consumption in the model of interaction of GDP per capita growth and economic freedom index have a positive effect on the food security and in the other models they have no negative effects on the food security that this matter is indicative of the weakness of institutional variables in the MENA region (Bates and Block, 2018; Bates and Block, 2013; Bates, 200; Paarlberg, 1999).

- *Energy consumption:* The energy consumption in the entire models has a negative effect on the food security. In case of the trade openness and the economic growth, therefore, the energy consumption will have a positive effect on the food security (Dithmer and Abdulai, 2017) but since the economic growth and income development in the MENA region is considered as one of the food security challenges so the energy consumption will have an inverse result on it (Breisinger et al., 2010).

- *Income (1):* The income which is arising out of the oil exports has a negative effect on the food security. Since the countries of the MENA region are among the biggest importers of foodstuffs and they must rely on the imports to provide themselves with their own nutritional requirements for 50% (World Bank, 2008), therefore, they have a major share of incomes arising out of the oil exports for ensuring the nutritional needs through the imports.

- *Income (2):* The income which is arising out of the gas exports in the entire models has a positive effect on the food security. With regards to the reviews which were done about this study, such positive effect can be due to the rents growth of natural gas in the target countries.

- *Precipitation and Rainfalls:* The precipitation and rainfalls have a negative effect on the food security which can be due to insufficient attention to the food insecurity problem (World Bank, 2017) and also because of the weakness of institutional variables in the MENA region (Bates and Block, 2018; Bates and Block, 2013; Bates 2006; Paarlberg, 1999).

- *Temperature:* The temperature in the model of economic indexes, natural resources and climatic changes and also in the models of GDP per capita growth interactions and the sub-indexes of governance will have a positive effect on the food security but these have not any significant effect on the food security in the other models. The temperature positive effects on the food production can be appropriate and beneficial for the stability and profitability purposes in the long run and because of understanding the food crisis and the necessity of obtaining and executing the required strategies in working out a solution for such problem by the governments of the MENA region (World Bank, 2017) that with regards to the presence of institutional variables in the model, such variable loses its

significant effect that this matter in this part can also be indicative of the weakness of institutional variables in the MENA region (Bates and Block, 2018; Bates and Block, 2013; Bates, 2006; Paarlberg, 1999).

Results' of Hasmen's test in the table below and for this model shows that the zero hypothesis of this test (The suitability of random effects) is rejected. In other words, in such model there is a correlation between the unobserved individual effects and explanatory variables and the impact of such factors will be fixed over time.

Table (16): Model Testing Results

| Type of test | Equation |
|---|---|
| Wu-Hausman test | 235.05 (Prob>chi2 = 0.0000) |

## Policy Solutions

The results arising out of this study specified that the main problem of food insecurity throughout the Middle East and North Africa region is due to the weakness of institutional variables including the prosperity, democracy, economic freedom, government's accountability, political stability, government's efficiency, regulatory quality, rule of law and control of corruption (Transparency).

The economic conditions improvement, business freedom, upgrading the economic opportunities, clarity and the lack of financial crises all can be among the best options for increasing the food security in the MENA region. In other words, economic power increase, economic growth increase and also creating the enlightenment by the governments all can be taken into consideration as some useful and appropriate strategies for increasing the food security.

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