

The Linkage Between Population Growth, Gdp And Food Security In Oman: Vector Error Correction Model Analysis

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Abstract: The paper examines the determinants of food security in Oman during the period 1980-2017. It investigates the influence of population growth rate and GDP per capita on food import bill. Cointegration and vector error correction model (VECM) approach have been used to identify the long term and short-term relationship of food security determinants. The finding indicates that food security in Oman is positively influenced by the population growth rate and GDP/capita. The error correction term suggests that 98 percent of the total disequilibrium in food security was being adjusted every year which a fast adjustment is justifiable for an oil producing country.

Index Terms: Cointegration and Vector Error Correction Model, Food Security, Oman, Population growth

1 INTRODUCTION

Food security is of a major concern worldwide. The 2018 Global Report on Food Crises estimated 124 million people in 51 countries are currently facing crisis of food insecurity. The demand for food is expected to grow substantially by 2050 due to the increase in world population which will reach 9.1 billion, 34 percent higher than today [17]. The United Nations Food and Agriculture Organisation (FAO) reported that world food production will have to increase by more than 75 per cent over the next 33 years to ensure food supplies for 9.6 billion people by the year 2050, compared to 7.5 billion today [21]. Food security is achieved by the large amount of food imports from various countries across the globe and increasing domestic food production. The Middle East currently imports about \$35 billion of food annually expecting a rise to \$70 billion in two decades due to unfavorable weather conditions in these countries as indicated by the International Center for Agricultural Research in the Dry Areas [29]. Similarly, Gulf countries will be spending \$53.1 billion in 2020 on food imports due to an increase of the population [8]. The needs of the GCC countries to suffice on food, prompted some of these countries to purchase lands as an investment in countries like Africa, Australia and Latin America. Maadid [5] reported that despite the differences amongst the GCC, their primary aim is to come together in unity for the pursuit of common security objectives including oil and food. Many countries with the highest number of people facing food insecurity have high fertility rates and rapid population growth [31].

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According to officials from the Ministry of Environment and Water at the World Food Security Summit in UAE the country's reliance on importing most of its food will continue to increase due to an increasing population, growing income and a change in consumption patterns [33]. (This information is optional; change it according to your need.) In the recent past, Oman has developed strategic planning and stringent policies to maintain its place as one of the most food secure nations in the Gulf Corporation Council (GCC). According to Global Food Security Index [23], Oman is ranked second among the six GCC nations, and 28th globally, among the 113 countries listed in the report. While Kuwait ranked first in the region, Qatar third followed by Saudi Arabia, UAE and Bahrain. However, in 2018, Oman rank declined to third in the GCC and 29th at the global level [36]. This may be attributed towards the oil price decline which further resulted in the decline of the Gross Domestic Product (GDP) of Oman. The import bill for Oman in 2010 was 19.9 billion, reached 23.26 billion in 2016 and increased to 27.15 billion in 2017 indicating an increase in the values of the food import bill. Regarding the percentage of the food import bill on total import bill, it showed an increase of 14% in 2017 compared to 9.25% in 2013[28]. As Oman is highly dependent on oil, the decline in the oil prices will affect its ability to import food and hence a threat to food security. Due to its low level of food production, Oman has strived hard to achieve self-sufficiency in food security. By the end of 2040, Oman is set to achieve a target of food sufficiency of 100 per cent, with an expected rise of 70-80 per cent by 2020 and the investments of \$4,941 million in agriculture and fisheries-related infrastructure projects made as per the Eighth Five-Year Economic Development Plan (2011-15), which has helped Oman to achieve 75.7 per cent self-sufficiency in vegetable production as reported by Oman's investment and export development agency (Ithraa) [40]. The increasing population in Oman, from 3.04 million in 2010 to 4.63 million in 2017 with a Compounded Annual Growth Rate (CAGR) of 6.20% to the dampening government revenues due to the decline in the oil prices has caused a lot of concern on food security. The impact of the population growth on food security in Oman, and its effect on the GDP need to be explored. The country's reliance on importing most of its food will continue to surge due to the rise in population. Understanding the dynamics of food import bill and GDP growth is important for

policy makers in Oman. The main objective of this paper is to explore the linkage of Food import bill with population and GDP growth. The remaining part of the paper is structured as follows. Section 2 will present the literature review.

2. LITERATURE REVIEW

Food security includes the access by all people at all times to enough food for an active, healthy life [56]. The concept of Food security is introduced in mid-1970s at the world food summit in 1974. According to The Committee on World Food Security in 1975 set up by UN World Food Conference reflected that food security has three dimensions: availability, access and utilization, although this source which was also endorsed by OECD [17]. Later, the Food and Agriculture Organization (FAO) of the United Nations, identified four dimensions for food security as food availability, food access, food use and food stability [52]. The increasing world population reaching 9.1 billion in 2050 expects a 34 percent rise in the demand for food [17]. Economic growth and diversification that initiates jobs for a majority of people, breaking the strong dependence to the international oil and food price shocks, managing depletion of water resources and effectively adapting to the climatic changes, transforming policies to target the poor, and empowering women to play a more active role in the economy and society of the country is very important to achieve food security [7]. This high reliance on the food depends on demand and supply factors. The demand factor is related to the growing population and food consumption which keeps on changing and the supply factor depends on the deficient natural resources such as land and water. In order to achieve food security, crops can be grown in a sustainable way without compromising the country's scarcity of water and land resource [34]. The study also recommended Oman to invest in buying or leasing land in land abundant countries and provide the people with family planning services and encourage nutrition education. Economic growth is sustainable if all countries have food security [10]. The combination of high food prices and volatile petroleum prices have the potential of inflating the pressure in the competition for expenditures intended for reducing poverty. Considering the region's high and increasing dependency on food imports, policy makers are concentrating on adopting more effective and sustainable measures to address the anticipated long-term increase in international food prices as well as increasing the food price volatility [4]. Further, the World Food Summit in 1996 demonstrated that food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life [52]. The Global report [23] on food crises reported that conflict and insecurity continued to be the most important drivers of food insecurity in 18 countries, where almost 74 million food-insecure people remain in need of urgent assistance. Therefore, food security remains a primary concern worldwide. Food insecurity in 2017 was driven by continuing conflict and insecurity throughout Africa, the Middle East and in parts of South Asia [38]. With a projected world population of 9 billion people by 2050 [58] achieving food self-sufficiency is very challenging. To meet the demand of the world's growing population, the food production will need to increase by 70 percent [27]. This food

sufficiency may be achieved by domestic production, imports in addition to food aid. Despite efforts to increase domestic agricultural and livestock production, GCC countries remain heavily dependent on food imports. 9.2 percent of the world population were exposed to severe levels of food insecurity in 2018, implying reductions in the quantity of food consumed to the extent that they have possibly experienced hunger [22]. Global demand for food is expected to double by 2030 with an expected 20 percent attributed to population growth [19]. In order to ensure the sufficiency of food to the growing population, there is a need to address the challenges that transcend decision making horizons of producers, consumers and policymakers [22]. Middle East and North Africa countries rely on global food markets and as the population increases then the demand also increases. Further, the high food prices have a major impact on import-dependent countries that, whatever the price, enough food may not be available on the international markets to satisfy their demands. One of the leading causes for food security in Africa is rapid population growth [25]. Therefore, Population growth has always been one of the demographic factors contributing to food insecurity. The study recommends increasing imports via trade and aid is very critical in the future but will be inhibited by social and economic issues. Another study shows that Congo's massive food imports represented a strategy for ensuring the country's food security, and also for supplying food products to neighboring countries [47]. The study investigating the relationship between selected macroeconomic variables (biodiesel production, exchange rate, government expenditure on rural development, Malaysia's GDP, food price index and Malaysia's population) and food security in Malaysia used VAR approach [3]. The findings indicated that population and GDP remain as important determinants as the shock showed a decreasing trend after the fifth year and sixth year respectively. There is reduction in food insecurity due to Growth in GDP and rising prices of food items despite continuous reduction in the share of Agriculture to GDP [1]. The Economic Report on Africa, showed that proportion of food-insecure in the population is expected to increase over the projection period by almost 10 per cent while food imports will increase by more than 7 percent annually in order to stabilize the proportion of food insecure people in the country [14]. Increasing food production is a key to providing continued upward growth in food supplies [24]. Hence some of the countries in the middle east are focusing on domestic production by improving their agricultural yields and buying land in other agricultural rich countries to suffice their food consumption in the future. Economic growth reduces income and poverty compared to food security [26] whereas some studies have proved a positive relationship between economic growth and food security [12, 51] and fewer studies found a negative relation in some regions of the world [13]. However studies have revealed that food insecurity in Ethiopia, is not due to the lack of economic growth and income distribution but derived from inflationary pressures, resulting from excess in the money supply, population growth, budgetary deficits, addressing the "supply side" of food production during favorable seasons [11]. Research scholars have indicated that food insecurity as one of the threats that society will experience during the 21st century due to the exponential growth in the population which is expected to increase to 9.3 billion in the year 2050 [57]. Despite the huge resources from

oil, Nigeria is facing the threat of hunger with 70 per cent of the population living on less than \$ 0.7 per day suffering from youth unemployment and high food imports [16]. On the demand side, there are lot of countries facing food insecurity considering their high fertility rate resulting in the rise in the population. Hence, we can say that population growth rate has a negative impact on economic growth [11]. Worldwide there are two approaches to address the relationship between food imports and food security. One is that the countries should be self-sufficient so that they meet their food needs fully from domestic production. The other is that their food needs are met through the food imports which is acquired by the revenues earned by exporting the goods. According to a study conducted in Nigeria [16] on yearly time series data from 1988 to 2017 applying a cointegration and error correction model determining the short and long-run dynamics of food inflation indicated that real GDP and food import were the key determinants of food price inflation. The researchers in Aalto university (2017) estimated that 1.4 billion people are dependent on food imports for food security. Further, 460 million people live in areas where even increased imports are not sufficient to balance the deficiency of local production. Hence resulting in a strong connection between scarcity in food production, population pressure and import of food [41]. Not all countries are expected to be self-reliant on food. Some countries may not be able to suffice in domestic food production. This may be due to the climatic conditions of the countries. Some others may not due to the limited export earnings and the high food demands relative to domestic food production. To mitigate the need for food security, the government should begin investing on the agriculture sector to meets the food needs. Oil and minerals exporting countries were able to build revenues to cover their food import bills to cope with the impact of the increasing food prices on their macroeconomic performance in the 2000's [50]. The MENA region is the most food import-dependent region in the world, with expected increase in net food imports. Economic growth raising the people's incomes is considered to be the most favourable driver of food security [7]. The report of Arab Forum for Environment and Development (AFED) indicated that Food imports in Arab countries is projected to reach US\$ 150 billion by 2050 and the reason for importing such huge quantities is lack of regulations and cooperation in the field of food security [46]. With a low risk of disruption, these countries will likely be able to afford food imports, if they can continue to export oil and gas. However, strategies to facilitate and maintain a supply of imported food remains critical to GCC countries [15] due to the fluctuating oil prices. Oil being a limited source of income and most of the population in the MENA region is younger than 30, it is very challenging to accelerate job growth and improve the living standards and food security of the rural and urban people of this region [7]. The increasing dependency of the near east and north African countries on imports of basic food commodities makes these countries vulnerable to the international food prices, thus raising concerns on the rising ratio of the food import bills to total merchandise export earnings [20]. Therefore, the governments in these regions are addressing these concerns by implementing short term remedies are highly reliable on food imports, they have the means to buy food and hence less vulnerable to rise in the food prices. National production, the exchange reserves available for importing foodstuffs and

the population growth are the main factors influencing food security [47]. It is well known that the capacity of any nation to finance food imports is solely depending on the level of the national income and the performance of the export sector including volume of foreign currency generated to finance food imports [45]. The revenues earned from, the exports and food prices on the international market have an effect on the food import capacity [47]. The per capita income being a function of GDP reflects on the country's capacity to import food products, ensuring food security.

3 OMAN SCENARIO

According to the forecast of United Nation's Food and Agriculture Organization (FAO), the food imports of Oman is expected to touch \$4.8 billion by 2020, when compared to \$2.1 billion in 2010. Given, that 60 percent of its food needs are met by international markets, [54] currently Oman is capable to finance the imports to meet the food security of its population. However, with the growing population, climatic conditions, urbanization and influx of tourists, the sufficiency of food is at a jeopardy. The number of foreign tourists visiting Oman is expected to increase at a Compounded Annual Growth Rate of 5.7 per cent between 2012 and 2017 [35] due to the government initiatives on tourism investments in the country, is likely to increase food consumption. The dependence of food on fuel export earnings have adverse effects on the macroeconomic growth of the countries through inflation, foreign exchange reserves and fluctuation in trade [55]. Any country is food secure if its total exports exceeds the total imports. The export earnings should be enough to meet the food imports of the country. It is identified that ratio of total exports to food imports is an indicator used to measure food security at the macro level [9,59]. Though the Oman government has taken initiatives and able to achieve a foreign direct investment (FDI) exceeding OMR 9.34 billion (USD 24 billion in the Sultanate at the end of 2017 [37], the decrease in the global oil prices from 2014 -2017 has had an impact on the Oman's budget due to the relatively expensive subsidies, expenditures, and job creation initiatives. Projecting a three billion Omani rial (10 percent of GDP) fiscal deficit in 2018, the government is concentrating on diversifying its economy towards industrial, food processing, logistics, information technology, tourism, healthcare, fisheries, and higher education sectors setting a goal of 81 percent of GDP by 2020 for the non-oil sector. [44] Due to the oil price shocks and the dependence of the oil price revenues on the food import of the country, the food security of Oman is a challenge. Hence it is very important to mitigate the challenge by designing strategies to accelerate food security. Since Oman is mostly rely on food imports for food sufficiency, food import bill is considered as a proxy for food security. From the literature discussed above, we observe that the key determinants of food import bill are population growth and GDP. Hence the study will validate the following hypothesis

H1: Population growth induces more demand for the food leading to increase food import bill.

H2: The Growth in GDP creates more demand for food and more pressure on food import bill.

4 RESEARCH METHODOLOGY

Cointegration and Vector Error Correction Model

In case of Cointegration and VECM in time series analysis, a spurious relationship arises when a vector autoregressive (VAR) model is applied to the series that are integrated. The solutions recommended are either using a VAR model on first difference or using a vector error correction model (VECM). The second solution is preferred as it provides the long relationship and produces efficient coefficient estimates.

The VECM equation is given as follows:

$$\Delta Z_t = \pi Z_{t-1} + \gamma \Gamma \Delta Z_{t-1} + \mu + \varepsilon_t$$

Where Z_t is (n×1) vector of the n variables, with (n×1) vector of constants. Γ represents (n×(k-1)) matrix of short-run coefficients, ε_t denotes a (n×1) vector white noise residuals and π is a (n×n) coefficient matrix. If the matrix π has reduced rank (0<r<n), it can be split into (n×r) matrix of loading coefficients α and a (n×r) matrix of cointegrating vectors β . The former indicates the importance of the cointegration relationships in the individual equations of the system and of the speed of adjustment to disequilibrium, while the latter represents the long term equilibrium relationship, such that $\pi = \alpha \beta'$, where k is the number of lags, t denotes the time and Δ is a difference operator.

4.1 The Econometric Model

The main objective of this paper is to explore the determinants of Food security in Oman which can be achieved using an econometric approach.

The estimated model will be as follows:

Food Import Bill = f(Population, GDP/capita(current) ; Food Import Bill (Valdes and Konandreas,1980) covers total amount spend on the Oman's imports, where Pop indicates the population growth rate of Oman, and GDP/capita(current) 47 indicates the Gross Domestic Product current per capita of Oman. The choice of these variables in the model was based on the literature support of these variables. All, the variables were converted to natural logarithms(ln) in order to reduce the variability in the variables provided by the author.

5 EMPIRICAL RESULTS

If you Table 1 provides the summary statistics for the Food import bill, which is used as a proxy for food security and its determinants and other variables population and GDP/Capita(current). Over the period 1980–2017, the average of the GDP/ Capita (current) is 9.18 with the highest coefficient of variation of 5.77. Population growth accounted to an average of 14.72 and coefficient of variation of 2.05 followed by Food import bill of 20.8 per cent with a coefficient of variation of 3.49 .

Table 1. Summary Statistics for the Model Variables

Variables	Minimum	Maximum	Mean	Standard Deviation	Coefficient of Variation
Food Import Bill	19.75	22.06	20.88	0.73	3.49
Population	14.22	15.35	14.72	0.30	2.05

GDP/ Capita(current)	8.45	10.00	9.18	0.52	5.77
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Table 2(a). Unit Root Unit Test (ADF) for the Model Variables

Variable	Level Critical Values					First Difference Critical Values				
	1 %	5 %	10 %	t-value	p-value	1 %	5 %	10 %	t-value	p-value
Food Import Bill	-	-	-	-	0.8	-	-	-	-	0.0
Population	3.62	2.94	2.61	0.56	6.33	3.62	2.94	2.61	3.2	2
GDP/capita(current)	-	-	-	-	0.8	-	-	-	-	0.0

Table 2(b). Unit Root Unit Test (ADF) for the Model Variables

Variables	Level Critical Values				t-value	p-value
	1%	5%	10%	t-value		
Food Import Bill	-3.63	-2.95	-2.61	-9.59	0.00	
Population	-3.67	-2.96	-2.62	-3.22	0.02	
GDP/capita(current)	-3.62	-2.94	-2.61	-6.33	0.00	

The results of the test of the stationarity of the series of the model are presented in table 2. The Augmented Dickey Fuller (ADF) test for Food import bill, population, GDP/ capita (current) The Table 2 presents the results of the stationarity of the series of the model. The Augmented Dickey Fuller (ADF) unit root test showed that at level, all the series are non-stationary with p>0.05. The t statistics for ADF test for FIB, Pop and GDP/capita(current) are not greater than the 1 per cent, 5 percent and 10 percent level of significance which implies that the variables are non-stationary in their level forms. In case of first difference, the ADF test showed that all the variables are stationary with p< 0.05, indicating all the variables are integrated of order 1. After formulating a Vector Autoregression (VAR) system containing Food Import Bill, Population and GDP/capita(current) The VAR lag order selection criterion is presented in Table 3

Table 3. VAR Lag Order Selection Criteria

Lag	Log L	LR	FPE	AIC	SC	HQ
0	-6.2514	NA	0.0003	0.561	0.697	0.606
1	116.567	215.863	3.56e-07	-6.337	-5.793	-6.154
2	164.238	75.177*	3.47e-08*	-8.681*	-7.729*	-8.361*

Note: *5% level

All the criteria including sequential likelihood ratio (LR), final prediction error (FPE), Akaike Information Criterion (AIC), Schwarz Criterion (SC), Hannan-Quinn Criterion (HQC) have called for two lags indicating lag two as the optimum lag in our model.

Table 4: Johansen Cointegration Test

Hypothesize d	Eigen value	Trace Statisti cs	5% Critical Value	p-value	Max- Eigen	5% Critical Value
None*	0.449	31.798 0	29.797	0.029	20.86	0.054
At most 1*	0.253	10.936	15.494	0.215	10.23	0.196
At most 2*	0.019	0.698	3.841	0.403	8	0.403

Note: * denotes rejection of the hypothesis at 5% level of significance

Since all the variables are integrated of the same order, Johansen Cointegration Test was applied and the results are shown in Table 4. The results of trace statistics exceeds the 5% critical value, there are 2 cointegrating equations at 5% level of significance, whereas max eigen value indicates one cointegrating equations. Table 5 shows the Error Correction Term I(ECT) in all the equations show positive as well as negative sign. However, in the ECT, the food import bill equation showed a coefficient of 0.98 which indicates that the adjustment towards the equilibrium takes place at 98 percent per annum. The cointegrating equation is negative and significant with the value of 0.986

Table 5: Error Correction Model

Error Correction:	D(LNFOOD IMPBILL)	D(LNPOP)	D(LNGDPPER CAPITACURRENT)
CointEq1	-0.986557 (0.35983) [-2.74171]	-0.000657 (0.00331) [-0.19855]	0.437333 (0.17448) [-2.50647]

The estimated model is as follows:

$$\text{Ln}(\text{foodimportbill}) = -7.53 + 1.68\text{Ln}(\text{population}) + 0.39\text{LnGDP/capita}(\text{current})$$

$$\text{Standard Error} = (2.77) + (0.26) + 0.151$$

$$R^2 = 0.90$$

The model indicates that if the population is increased by 1% food import bill is 1.68. If the GDP/capita(current) increases by 10 %, then food import bill will increase by 3.9%. The value of R^2 , indicates 90% variation in food import bill is influenced by the population and GDP/capita(current).

6 DISCUSSION

From the above analysis, food import bill which is considered as a proxy of food security is positively related to population and GDP/capita(current). The results are in consistent with the literature.39,42 It is observed that out of the two determinants, population growth has the maximum influence on food security. As the challenge of today is to provide the world's growing population with a sustainable, secure supply of safe, nutritious, and affordable high quality food, Oman has been committed to integrated package of various projects in line with the government's plans that aim at achieving food security in the Sultanate of Oman [40]. The 98% adjustment in the Error Correction term of the food import bill of cointegration equation indicates that if any disequilibrium occurs the system adjusts in one year which is justifiable for an oil producing country like Oman [43].

7 CONCLUSIONS AND POLICY IMPLICATIONS

The paper examined the determinants of the food import bill in

Oman during the period of 1980 to 2017 and revealed that the main determinants of the food security are population growth rate and current GDP/capita. Based on the data analysis, Food security is positively influenced by population and current GDP/capita. Out of which, food security is largely influenced by the population growth rate. It is very important for any country to develop its own food security strategy, which may otherwise result in a negative effect on human capital that results in negative consequences on government expenditures. Further leading to stagnated economic growth in the long term. Thus, a proper food security strategy is an essential for all countries. Hence it is highly recommended to the policy makers to consider the growth rate of the population while framing food security policies for long term food sustainability in Oman.

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