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Analysing the Role of Food Security, Agricultural Exports and Income Inequality in Shaping Economic Growth Trajectories in Developing Countries

Sumaira Batool[1]; Muhammad Ramzan Sheikh[2]
1. PhD Economics Scholar, School of Economics, Bahauddin Zakariya University, Multan, Pakistan
Email: sumairaimran14@gmail.com
2. Professor of Economics, School of Economics, Bahauddin Zakariya University, Multan, Pakistan
Email: ramzansheikh@bzu.edu.pk

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Corresponding Author's email:
ramzansheikh@bzu.edu.pk

ABSTRACT

This study examines the impact of food security, agricultural exports and income inequality on economic growth in 89 developing nations from 1990 to 2020. Employing Method of Moments Quantile Regression (MMQR), it analyses all four dimensions of food security, which include availability, access, stability and utilization. Key findings include positive impact of adequate food availability on economic growth through promoting health as well as productivity. Prevalence of undernourishment negatively affects economic growth, indicating its role in reducing labor productivity and exacerbating poverty. Food stability, measured by per capita food production variability, shows a significantly negative impact on economic growth. Access to improved drinking water is positively associated with food utilization and economic growth. The study recommends interventions to promote labor force participation, infrastructure investment, reduced income inequality and financial system development for sustainable economic growth in developing countries.

1 Introduction

Food security was firstly defined in 1943 and since then is of great concern. The conception of food security has developed significantly during previous seventy years and it is now an embedded notion. In 1948 Universal Declaration of Human Rights, United Nations recognized that the right to adequate food was a human right. As food is essential to human development and well-being so increase in the production of food always remained a cornerstone strategy in the struggle of alleviation of global food insecurity. Regardless of good increase in global food production during last half century, over two billion people do not have sufficient food to eat; around three billion people lack enough nutritious food while over 700 million people face hunger (FAO 2021). There is a vast range of factors which are responsible for such food insecurity. A lot of challenges regarding the equitable access of food are usually intensified in developing countries where environmental pressures i.e. population growth, climate change and other socio-economic issues like poverty and inequality are concentrated. These factors collectively hamper the individuals' access to sufficient and healthy food primarily through affecting incomes, livelihood and food prices. Food security and human development go with one accord and their results are also codetermined to a considerable degree.

Food security, agricultural exports and income inequality are key issues in the domain of economic growth. As regard foreign exchange earnings, agricultural exports are a fundamental source for many developing countries as they contribute significantly to economic growth. In many developing countries, income inequality is a prevalent issue. It has important implications for economic growth.

Attainment of food security ensures access of all individuals within a society to sufficient quantity of safe and nutritious food which fulfils their dietary needs. Though, for a number of developing nations, achieving food security is a significant challenge due to issues such as poverty and income inequality. In present era, food security, agricultural exports and income inequality have become focus of development economists to enhance economic growth and development. Regarding these variables a mixed and complex relationship has found in the literature. These existing studies recommend that economic growth is positively affected by food security and agricultural exports as it enhances productivity of agricultural sector and results in increasing the incomes of individuals. Various studies conclude that food security increases the economic growth of developing countries (Agboola & Bacılar, 2014; Manap & Ismail, 2019; Fernandes & Samputra, 2022; Sheikh et al., 2022; Sauranbai et al., 2022). On the other hand, economic growth can be hampered by income inequality through decreasing the effectiveness of government policies and deteriorating the political and social stability. In such perspective, the present study explores the intricate relations among income inequality agricultural exports, food security and economic growth of developing economies.

A number of related factors comprising food security, agri. exports and income inequality have significant impact on the economic growth of developing countries. Regardless of the efforts done to enhance growth, the issue of food security hampers the productivity of human capital. Likewise, inequality in the distribution of income also impedes the process of economic growth. On the other hand, agricultural exports play a supporting role to enhance economic growth. The study examines how food security and agricultural exports influence economic growth positively and by what means income inequality can deter it. By examining these relations, the opportunities and problems can easily be understood so that the issue of food security can be addressed properly. The specific objective of the present study is to probe the effects of food security indicators on economic growth. The study has organized as: Section 2 presents a comprehensive literature review that considers the link between food security and agricultural exports, income inequality and economic growth respectively. Section 3 details the model specification, provides insights into the data and explores the methodology. Section 4 deals with and discussion based on findings from MMQR for the effect of all dimensions of food security on economic growth of developing countries. Section 5 of the study manifests a summary of the study along with the conclusion and recommendation.

2 Literature Review

A wide range of studies have been conducted on the relation of food security and economic growth globally. This section reveals a varied set of studies that have comprehensively analyzed the multidimensional association between these variables. More than a number of years, the effect of economic growth on food security has been examined in order to explore whether food security improves as a result of economic growth.

By tracing a food security nexus, Tweeten (1999) argued that both transitory and chronic food insecurity were primarily attributed to poverty and should have been addressed through economic development. In addressing the question of how to escape the threat of hunger and famine, as opposed to merely seeking solutions, Timmer (2000) delved into an extensive body of literature. The study demonstrated that strategies such as pursuing growth with unchanged income distribution and concentrating on economic growth with a focus on redistribution are viable approaches. By scrutinizing 63 developing economies during the period 1960-1970 through panel data analysis, the researchers identified positive association between income growth and child under-nutritional status. A lot of research has been done on country level that focused the connection between average levels of earning and resulting demand for food. Kiminami (2009) investigated the effect of economic growth on food consumption by taking the income gap into account for Asia. The study showed that in case of East Asia, although change in the degree of transition regarding per capita rice consumption, the consumption of rice decreased as a whole with growing incomes. The author concluded that it was necessary for a sustainable economy that minimum level of food security must

be fulfilled from the present to future. Moreover, there should exist a balance between the present and future level of food security caused by resource as well as environmental constraints. The study suggested that to realise sustainable society, food security was prerequisite for balance with efficiency in food production for all East Asian countries including China.

After examining the enduring effects of food security on economic growth, Agboola (2009) utilized a dataset from 124 countries, which included food-insecure African countries and food-secured countries from the rest of the world. The researcher used panel data from 1970/74-2000/09 with a five-year average to determine whether the long-run factors of economic growth differed between food-insecure countries of African region and food-secured countries of rest of the world. The results revealed that food availability was a key factor to determine economic growth in the countries under consideration. Additionally, food security served as a significant differentiating factor in the economic growth of these countries. The researcher further argued that the effect of food availability on economic growth was positive for other countries in the long-run, while in the case of African food-insecure countries, it turned negative due to the source of food availability, primarily through donations from developed nations, which resulted in disruptions in the food market.

By taking the new momentum of rapidly changing world regarding the promotion of rising domestic challenges in case of MENA countries, Breisinger et al (2010) used food security for determination of regional challenges. The researchers concluded that to foster development food security and diversification were extremely required by which jobs for majority of people could be generated, social policies to target especially poor could be transformed and women should be empowered to participate more actively for the betterment of the economy. Based on MDGs of poverty and hunger eradication McMichael & Schneider (2011) compared the two diverse paradigmatic approaches associated with food security and their ecological as well as political repercussions. The researchers tried to find out the role of agriculture in economic growth (agricultural value-chain approach) or actually serve as multifunctional approach i.e. related to food sovereignty. By reviewing responses to food crises of 2006-2008 the researchers tried to find whether the strategy of promoting the small farmers to incorporate in to the global markets through value-chains, in other words industrial agriculture is a better strategy as compared to the food sovereignty politics. With the help of a rich dataset comprising on 124 developing countries Agboola and Bacılar (2014) attempted to examine the hypothesis of vital effect of food security to spur the developing economies' economic growth. The researchers concluded that improved food security contributes to the improved economic growth.

Ghanem (2015) conducted a study on Morocco and linked the objectives of inclusive growth with the food security keeping in view Morocco's twin problem i.e. child malnutrition and obesity. According to the researcher to achieve inclusive growth and food security the government focused on a rural development strategy with two important pillars: one of which focused on large modern farms and the other pillar concentrated on supporting family farming and small holders. Because the aim of poverty reduction required support to the family farmers and smallholders as they represented most poor people in Morocco and then it resulted in increased production of food and improved food security. The paper suggested that to meet inclusive growth along with food and nutrition security an approach must focus on increasing food reserves, linking family farmers to the national and international markets and introduction of social protection system for rural poor.

With the understanding that the vertices of a triangle are represented by economic growth, health and food security, Pourreza et al. (2018) studied the association among these three factors. The researchers indicated that achieving food security was not only approaching food and nourishing people but had importance from practical point of view from all aspects of a society and economy also. The authors claimed that health is about measuring the efficiency of people as well as their overall well-being and thus good health have positive effects on the productivity, efficiency, utility income and ultimately on economic growth. As a result, sound health has sizable, favourable and

substantial effects on economic growth. The research concluded that food security was not just about accommodating good health but served as the grounds for attainment of sustainable economic growth also. Furthermore, the researchers emphasized that without food security strategy, a country would have to face adverse effects on human capital, which would lead to stagnated economic growth and it is possible with the proper coordination of various sectors of economy including agriculture, health and nutrition, finance and infrastructure. In their 2019 study, Chemin et al. explored the role of CIDA to concentrate on stimulating sustainable economic growth within two of its primary areas of concern: developing and middle-income countries. The researchers explained the various channels through which this growth could be promoted, considering opportunities that had been previously overlooked at different levels. At the national level, the research highlighted the significant role of the judiciary in enhancing food security and fostering economic growth and development. At local level, the research suggested that enhancing food security required the formulation of policies to bridge the economic and social dimensions of micro, small and medium-sized businesses effectively. The paper recommended that CIDA could improve food security by adopting strategies aimed at reducing food price volatility. Moreover, food aid was considered as the alternative way that can enhance food security at global scale.

Berchin et al., (2019) examined a vast literature to explore the effect of Brazilian government policies focused on boosting family farming to improve food security. "Poverty" was identified as the major reason of food insecurity. The results found that to ensure the access to food and stable food supply poverty should be addressed properly. Moreover, the study concluded that along with the government policies focusing on education, poverty reduction and healthcare, household farming is very beneficial for food security. Afterwards, it results in increasing incomes through the economic growth and poverty reductions helps in improvements in the quality of life. The study recommended that Brazil's approach can be an example for other developing countries as well. Other developing nations can design their policies with a focus on strategies including technical and financial assistance, food provision, adoption of land tenure system and capacity building. These policies were resulted in enhancing the food security in a most effective way. For a panel data set during 1970-2016 for 75 dry-land developing countries, Manap & Ismail (2019) estimated the direct impact of food security on economic growth as well as its impact through various factors including total employment and poverty. The authors found that, in the case of dry-land developing countries, food security had affected economic growth significantly. The enhanced food security had resulted in poverty reduction. By employing MMQR Sheikh et al., (2022) estimated the nexus between food security, food wastage, environment and economic growth for developing nations. Through data utilization from 1990 to 2021, the researchers found that economic growth increased as a result of improved food security in developing countries.

3 Model, Data, and Methodology

Model-1: Economic Growth Model based on Food Availability

$$Q_{GDPPC_{it}}(\tau \mid \gamma_i, \delta_t, X_{it}) = \gamma_i + \delta_t + \eta_{1,\tau} LFPR + \eta_{2,\tau} GFCF_{it} + \eta_{3,\tau} APS_{it} + \eta_{4,\tau} GI_{it} + \eta_{5,\tau} ARM_{it} + \eta_{6,\tau} SSE_{it} + \eta_{7,\tau} M2_{it} + \eta_{8,\tau} TAX_{it} + \mu_{\tau,it} \quad \textbf{(1)}$$

Model-2: Economic Growth Model based on Food Access

$$Q_{GDPPC_{it}}(\tau \mid \gamma_i, \delta_t, X_{it}) = \gamma_i + \delta_t + \eta_{1,\tau} LFPR + \eta_{2,\tau} GFCF_{it} + \eta_{3,\tau} PUN_{it} + \eta_{4,\tau} GI_{it} + \eta_{5,\tau} ARM_{it} + \eta_{6,\tau} SSE_{it} + \eta_{7,\tau} M2_{it} + \eta_{8,\tau} TAX_{it} + \mu_{\tau,it} \quad \textbf{(2)}$$

Model-3: Economic Growth Model based on Food Stability

$$Q_{GDPPC_{it}}(\tau \mid \gamma_i, \delta_t, X_{it}) = \gamma_i + \delta_t + \eta_{1,\tau} LFPR + \eta_{2,\tau} GFCF_{it} + \eta_{3,\tau} PFPV_{it} + \eta_{4,\tau} GI_{it} + \eta_{5,\tau} ARM_{it} + \eta_{6,\tau} SSE_{it} + \eta_{7,\tau} M2_{it} + \eta_{8,\tau} TAX_{it} + \mu_{\tau,it} \quad \textbf{(3)}$$

Model-4: Economic Growth Model based on Food Utilization

$$Q_{GDPPC_{it}}(\tau \mid \gamma_i, \delta_t, X_{it}) = \gamma_i + \delta_t + \eta_{1,\tau} LFPR + \eta_{2,\tau} GFCF_{it} + \eta_{3,\tau} IDW_{it} + \eta_{4,\tau} GI_{it} + \eta_{5,\tau} ARM_{it} + \eta_{6,\tau} SSE_{it} + \eta_{7,\tau} M2_{it} + \eta_{8,\tau} TAX_{it} + \mu_{\tau,it} \quad \textbf{(4)}$$

where τ indicates quantiles such as 10th, 25th, 50th, 75th and 90th

$i = 1, \ldots\ldots N$ represent cross sections, and t shows the time period starting from $t = 1, \ldots\ldots T$, $GDPPC_{it}$ is the dependent variable.

Where:

LFPR = Labor force participation rate, (total % of total population ages 15-64)

GFCF = Gross fixed capital formation (% of GDP)

APS = Average protein supply (g/cap/day, 3-year averaged)

PUN = Prevalence of undernourishment (%, Yearly estimates)

PFPV = Per capita food production variability (Constant 2014-2016 thousand international $ per capita)

IDW = People using at least improved drinking water services (% of population)

GI = Gini index (Annual %)

ARM = Agricultural raw material exports (% of merchandise exports)

SSE = School enrolment, secondary (% gross, Annual)

M2 = Broad money (% of GDP, Annual)

TAX = Tax revenue (% of GDP, Annual)

Data and Methodology

To conduct the empirical analysis in the present study, data has been precisely sourced from two distinct repositories, namely, the comprehensive repository of Food Security Indicators (FSI) and the extensive World Development Indicators (WDI) database. The selection of 89 developing countries from the larger pool of 121 was undertaken with precision, guided by the availability of required data within both data sources. Specifically, according to the World Bank classification of countries among the selected 89 developing countries, 26 are classified as low-income countries, while 54 fall within the lower middle-income category. The remaining 54 countries are categorized as upper middle-income countries. The time span for this study embraces the years 1990 to 2020. Moreover, MMQR technique by Machado and Silva (2019) has been used to explore the impact of food security, agricultural exports and income inequality on economic growth of developing economies.

4 Results and Discussions

This section demonstrates the results of the study in detail. It encompasses summary statistics of key variables.

4.1 Descriptive Statistics of Key Variables

Table 1, presents the descriptive statistics of key variables including mean, maximum (highest) and minimum (lowest) values observed within the variable series of thes variables under consideration. Table 1, is showing the standard deviation of the variable included, where the M2 (Broad Money) has the highest value of standard deviation among the included variables while the variable of economic growth GDPPC has the lowest value of standard deviation. It can be observed from Table 1, that the dataset appears to be fairly symmetric. As Table 1, is showing that variables used in the study exhibited positive as well as negative skewness. Particularly, the GDPPC (GDP per Capita Growth), IDW (People using at least drinking water services), GI (Gini Index) are negatively skewed while the remaining variables are positively skewed

Table 1

Descriptive Statistics of Key Variables of Food Security Models (1990-2020)

Variables	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability
GDPPC	2.04	53.97	-64.99	5.67	-0.93	24.66	54315.00	0.00
LFPR	61.71	128.06	25.90	13.11	0.05	2.96	1.04	0.60
GFCF	22.81	93.55	-2.42	9.17	1.21	7.35	2535.86	0.00
APS	64.49	118.10	30.00	13.89	0.64	3.24	172.74	0.00
PUN	19.77	80.80	-45.20	14.15	0.65	4.18	314.21	0.00
PFPV	10.43	107.40	-6.10	10.92	3.71	23.88	50195.15	0.00
IDW	75.09	107.10	1.60	19.05	-0.75	2.93	232.35	0.00
GI	42.48	84.41	-11.93	9.47	-0.15	4.74	319.87	0.00
ARM	6.91	98.95	-5.25	12.60	3.25	14.51	17848.11	0.00
SSE	52.81	142.02	5.22	27.44	0.22	2.10	103.64	0.00
M2	39.38	211.89	-47.63	27.86	1.90	8.57	4642.78	0.00
TAX	15.18	147.66	0.91	12.47	5.60	42.35	171115.40	0.00

Source: Authors' computations

From the Table 2, it can be observed that apart from LFPR (labor force participation rate) and PFPV (per capita food production variability), all the other quantitative variables exhibit cross-sectional dependence across countries.

Table 2

Pesaran's Cross Sectional Dependence (CD)Test

Variable	CD-test	p-value
GDPPC	57.45	0.00
LFPR	-0.87	0.38
GFCF	24.46	0.00
APS	196.00	0.00
PUN	102.20	0.00
PFPV	-1.09	0.27
IDW	167.46	0.00
GI	22.49	0.00
ARM	40.03	0.00
SSE	205.88	0.00
M2	159.53	0.00
TAX	10.92	0.00

Source: Authors' computations

However, despite the presence of Pesaran's Cross-sectional Dependence (CD) relationship, the countries under study can also maintain their own independent dynamism and assume homogeneous slope coefficients that can provide misleading results (Pesaran & Yamagata, 2008). It is

therefore necessary to conduct slope homogeneity test. So, we have tested the slope homogeneity/heterogeneity test. For this purpose, two tests are commonly used: (i) the Delta test presented by Pesaran and Yamagata, 2008; (ii) the HAC Robust Delta test or Delta Adjusted test by Blomquist and Westerlund, 2013.

4.2 Slope of Homogeneity Test

Table 3, presents the results of the homogeneity/heterogeneity test for all four models of economic growth.

Table 3

Slope Homogeneity Test

Model	(Pesaran and Yamagata, 2008)		(Blomquist and Westerlund, 2013)	
	Delta Test	P-Value	HAC Robust Adjusted Delta Test	P-Value
GDPPC/ LFPR, GFCF, APS, GI, ARM, SSE, M2, TAX	37.08	0.00	-15.55	0.00
GDPPC / LFPR, GFCF, PUN, GI, ARM, SSE, M2, TAX	44.62	0.00	-14.66	0.00
GDPPC / LFPR, GFCF, PFPV, GI, ARM, SSE, M2, TAX	44.97	0.00	-14.92	0.00
GDPPC / LFPR, GFCF, IDW, GI, ARM, SSE, M2, TAX	46.18	0.00	-15.00	0.00

Source: Authors' computations

Firstly, the slope homogeneity test has applied on the economic growth model based on food availability and indicated that in case of both tests of homogeneity the null hypothesis has been rejected and an evidence of heterogeneous slopes prevails. Secondly, for the model of economic growth based on food access alternative hypothesis of heterogeneity has been accepted. Likewise, the models of economic growth based on food stability and utilization also showed that in case of Pesaran and Yamagata (2008) and Blomquist and Westerlund (2013) tests of slope homogeneity an evidence of heterogeneous slopes prevails and the null hypothesis has been rejected. In short, the findings indicate that for all the four models of economic growth suggest that the slope is heterogeneous for all countries in both tests.

4.3 Unit Root Tests

In this section, we will discuss the results of Im-Pesaran-Shin (CSDIPS) unit root test by keeping in mind our CD related data.

Table 4

Slope Homogeneity Test

Second Generation Panel Unit Root Test						
Cross-Section-Dependence based Im-Pesaran-Shin (CSDIPS) Unit Root Test						
Variables	**Without Trend**			**With Trend**		
	Lags	**Zt Statistics**	**P-Value**	**Lags**	**Zt Statistics**	**P-Value**
LGDP	0	-17.33	0.00	1	-5.76	0.00
LFPR	0	-3.19	0.00	0	-1.79	0.00
GFCF	0	-6.36	0.00	1	-4.13	0.00
APS	0	-7.39	0.00	0	-3.36	0.00
PUN	0	1.54	0.93	1	-16.13	0.00
PFPV	0	-4.52	0.00	0	-5.91	0.00
IDW	0	3.88	1.00	0	-0.94	0.10

GI	0	-5.93	0.00	0	-4.76	0.00
ARM	0	-6.91	0.00	0	-3.49	0.00
SSE	0	-3.23	0.00	1	-2.07	0.01
M2	0	-5.81	0.00	0	-0.32	0.00
TAX	0	5.98	1.00	1	0.66	0.00

Source: Authors' computations

So, we have applied the second generation of unit root test that consider the CD properties of data. The results of Im-Pesaran-Shin (CSDIPS) unit root test are presented in Table 3.

The results of the panel unit root test have applied on two equations i.e. without trend and with trend. The results of the unit root test have shown that except two variables all the other variables are stationary. Only the IDW (improved drinking water services) and SSE (secondary school enrollment) are non-stationary or has unit root.

4.4 Panel Cointegration Analysis

In order to ascertain the existence of a non-spurious long-run relationship between the variables continuing with our research, we have performed three cointegration tests namely; Kao test, Pedroni test and Westerlund test. In case of Kao test three test statistics, Dickey-Fuller, Augmented Dickey-Fuller and Modified Dickey-Fuller have been used. Regarding the Pedroni test, results are exhibited in the form of Phillips-Perron test, Modified Phillips-Perron test and Augmented Dickey-Fuller test. As far as the Westerlund test is concerned, here four test statistics are given i.e. Gt, Ga, Pt and Pa.

Table 5

Cointegration Tests Results

Cointegration Tests

Model	**Kao Test**			**Pedroni Test**			**Westerlund Test**			
	Dickey-Fuller t	**ADF**	**Modified Dickey-Fuller t**	**Phillips-Perron t**	**Augmented Dickey-Fuller**	**Modified Phillips-Perron t**	**Gt**	**Ga**	**Pt**	**Pa**
LGDP/ LFPR, GFCF, APS, GI, ARM, SSE, M2, TAX	-6.31	-8.16	-6.28	-2.56	-0.25	10.10	-0.99	-2.31	-12.12	-3.74
	(0.00)	(0.00)	(0.00)	(0.00)	(0.39)	(0.00)	(0.88)	(0.76)	(0.56)	(0.12)
LGDP/ LFPR, GFCF, PUN, GI, ARM, SSE, M2, TAX	-6.21	-7.96	-6.01	-3.82	-0.55	9.29	-0.80	-2.01	-2.66	-0.72
	(0.00)	(0.00)	(0.00)	(0.00)	(0.29)	(0.00)	(0.23)	(0.00)	(0.87)	(0.99)
LGDP/ LFPR, GFCF, PFPV, GI, ARM, SSE, M2, TAX	-6.06	-7.93	-5.91	-3.01	-0.40	10.38	-0.72	-1.42	-3.57	-0.80
	(0.00)	(0.00)	(0.00)	(0.00)	(0.34)	(0.00)	(0.00)	(0.23)	(0.03)	(0.00)
LGDP/ LFPR, GFCF, IDW, GI, ARM, SSE, M2, TAX	-6.99	-8.86	-7.61	-2.42	0.71	10.05	-0.99	-2.16	-5.45	-1.23
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.23)	(0.00)	(0.65)	(0.02)	(0.00)

Note: The values in the parenthesis are p-values.

Source: Authors' computations

The results of panel cointegration analysis have shown in the Table 5. The results of Table 5 elaborates that in case of Kao test a long-run relationship exists for all variables included in the study. The results

of Pedroni test have shown existence of long- run relationship in case of majority of variables. Whereas, regarding the Westerlund test, a few of the included variables have not shown the existence of long-run relationship. So, we conclude that overall a long-run relationship exists and we have rejected the null hypothesis of no cointegration.

4.5 Method of Moments-Quantile Regression Results of Economic Growth

In this research, we have employed the Method of Moments-Quantile Regression (MMQR) to estimate models of economic growth for the four dimensions of food security: food availability, food access, food stability and food utilization. The results for all four estimated models have been presented in this section, with each model's results discussed in a separate table. The results regarding each dimension of food security are depicted in the respective tables. It can help in comparing the results of all dimensions. By analysing each dimension of food security separately through MMQR, the understanding of the relationship of food security and economic growth can be provided preciously.

Table 6

MM-QR Results of Economic Growth Model based on Food Availability

DV = Per-Capita GDP (GDPPC)							
Variables	**Location**	**Scale**	**Q 0.10**	**Q 0.25**	**Q 0.50**	**Q 0.75**	**Q 0.90**
LFPR	0.02***	-0.02***	0.06***	0.04***	0.02***	0.00	-0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
GFCF	0.19***	-0.02	0.23***	0.21***	0.20***	0.17***	0.16***
	(0.03)	(0.02)	(0.04)	(0.03)	(0.03)	(0.04)	(0.05)
APS	0.09***	-0.09***	0.24***	0.17***	0.07***	0.00	-0.04
	(0.02)	(0.01)	(0.04)	(0.03)	(0.02)	(0.02)	(0.02)
GI	-0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ARM	-0.03***	0.01***	-0.05***	-0.04***	-0.03***	-0.02***	-0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SSE	0.02***	0.00**	0.02***	0.02***	0.02***	0.02***	0.03***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
M2	0.01***	0.00***	0.00	0.00***	0.01***	0.01***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
TAX	0.16***	-0.05***	0.24***	0.21***	0.17***	0.12***	0.08***
	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
CONSTANT	20.13***	2.310***	16.06***	18.18***	20.41***	22.14***	23.53***
	(0.36)	(0.26)	(0.70)	(0.50)	(0.35)	(0.32)	(0.39)
Observations	2,759	2,759	2,759	2,759	2,759	2,759	2,759

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: Authors' computations

Important and useful understandings of the relationship between food security and economic growth are obtained by the MMQR approach. Particularly, the results of MMQR analysis for first dimension of food security i.e. "availability" are presented in Table 6. For the sake of analysis other explanatory variables were incorporated in the model are LFPR, GFCF, GI, ARM, SSE, M2 and TAX. The results revealed that economic growth is affected positively and significantly by LFPR and GFCF. Our results for LFPR seconds the results already concluded by various empirical studies (Clark et al., 1999; Duval et al., 2010; Edeme et al., 2016; Haque et al., 2019; Oyelade & Oghenetega, 2020). Moreover, the results of our study are in line with a considerable number of studies by showing a positive impact of capital formation (GFCF) on economic growth (Bakare, 2011; Ugochukwu & Chinyere, 2013; Kanu &

Ozurumba, 2014; Jaiyeoba, 2015; Ali, 2015; Shuaib & Ndidi 2015; Ncanywa & Makhenyane, 2016; Edeme et al., 2016; Boamah et al., 2018; Haque et al., 2019; Kong, 2020).

Adequate food availability, as measured by average protein supply (APS), positively influences economic growth by promoting good health and productivity. Moreover, the result of our study aligns with the results of previous studies (Correa & Cummins, 1970; Agboola, 2009; Bacilar, 2014; Manap & Ismail, 2019). The studies have revealed that food availability is a crucial factor in determining economic growth in developing countries as improved food availability certainly contributes to the improved economic growth of developing countries as a whole. On the other hand, reliance on agricultural exports (ARM) has negative impacts on economic growth. Now, turning to the measure of income inequality i.e. GI, our results have shown insignificant impact on GDPPC. Some other studies have also found no conclusive relationship between income inequality and economic growth. The result of GI agrees with the previous studies by Niyimbanira (2017), Benos & Karagiannis (2018) and Brueckner & Lederman (2018) which concluded that there exist no relationship between income inequality and economic growth. Secondary school enrollment positively impacts economic growth through human capital development and technological progress. Furthermore, financial development (represented by M2) and effective fiscal policies (reflected in tax revenue) positively contribute to economic growth.

The results of economic growth model based on food access are presented in Table 7. For our second model of food security, based on food access measured through PUN, all the explanatory variables have depicted the same impact on GDPPC of developing countries as the first model of food security based on first dimension of food security i.e. food availability.

Table 7

MM-QR Results of Economic Growth Model based on Food Access

DV = Per-Capita GDP (GDPPC)							
Variables	**Location**	**Scale**	**Q 0.10**	**Q 0.25**	**Q 0.50**	**Q 0.75**	**Q 0.90**
LFPR	0.019***	-0.00**	0.02***	0.02***	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
GFCF	0.72***	0.04***	0.65***	0.68***	0.72***	0.75***	0.78***
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
PUN	-0.28***	-0.01	-0.24***	-0.26***	-0.28***	-0.29***	-0.31***
	(0.02)	(0.01)	(0.03)	(0.03)	(0.02)	(0.03)	(0.04)
GI	-0.00*	-0.00	-0.00	-0.00	-0.00**	-0.00**	-0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ARM	-0.03***	0.00**	-0.04***	-0.03***	-0.03***	-0.03***	-0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SSE	0.01***	0.00	0.01***	0.01***	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
M2	0.01***	0.00***	0.00	0.01***	0.01***	0.01***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
TAX	0.56***	0.02	0.52***	0.54***	0.56***	0.58***	0.59***
	(0.02)	(0.01)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)
CONSTANT	22.00***	1.47***	19.43***	20.95***	22.18***	23.30***	24.24***
	(0.29)	(0.20)	(0.55)	(0.38)	(0.28)	(0.26)	(0.32)
Observations	2,747	2,747	2,747	2,747	2,747	2,747	2,747

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: Authors' computations

Whereas according to Table 7, the impact of PUN on the economic growth of developing countries is negative and statistically significant for almost all quantiles. It implicates that undernourishment in developing countries hinders economic growth by reducing labour productivity and exacerbating

poverty and income inequality. Inadequate nutrition leads to cognitive and physical impairments, limiting individuals' ability to participate effectively in economic activities. This perpetuates a cycle of underdevelopment and makes it challenging to break free from the poverty trap. Undernourishment is also associated with shorter life expectancy, particularly in countries with limited access to adequate nutrition. Overall, the negative impact of undernourishment on economic growth worsens income disparities, perpetuates poverty and hampers sustainable development. The result of PUN agrees with the previous studies by Jean-Louis Arcand (2001); Bain et al., (2013) and Manap & Ismail (2019), which also revealed that PUN has unfavourable effects on the economic growth of developing countries.

Table 8

MM-QR Results of Economic Growth Model based on Food Stability

DV = Per-Capita GDP (GDPPC)							
Variables	**Location**	**Scale**	**Q 0.10**	**Q 0.25**	**Q 0.50**	**Q 0.75**	**Q 0.90**
LFPR	0.01***	-0.00***	0.02***	0.02***	0.01***	0.01***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
GFCF	0.04***	0.02**	0.00	0.01**	0.03***	0.05***	0.08***
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.03)
PFPV	-0.05***	-0.13***	-0.12***	-0.05***	-0.01	-0.11***	-0.27***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.04)
GI	-0.00**	-0.00	-0.00	-0.00*	-0.00**	-0.00***	-0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ARM	-0.03***	0.00**	-0.04***	-0.03***	-0.03***	-0.03***	-0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SSE	0.02***	0.00***	0.01***	0.01***	0.02***	0.02***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
M2	0.01***	0.00***	0.00**	0.01***	0.01***	0.02***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
TAX	0.01	0.04***	0.07***	0.04***	0.01	0.02	0.05***
	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
CONSTANT	21.68***	1.315***	19.46***	20.70***	21.84***	22.88***	23.63***
	(0.29)	(0.20)	(0.54)	(0.38)	(0.28)	(0.27)	(0.31)
Observations	2,748	2,748	2,748	2,748	2,748	2,748	2,748

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: Authors' computations

Results of all explanatory variables other than the basic variables used to measure the third and fourth dimensions of food security (presented in Table 8 and Table 9 respectively) are same as the first model based on food availability dimension of food security. In the third model based on food stability measured through PFPV, MMQR results have shown a significantly negative impact of PPFP on GDPPC of developing countries. Higher variability in per capita food production in developing countries is negatively correlated with economic growth, indicating that fluctuations in food production have a detrimental effect on economic progress. The instability in the agricultural sector, characterized by varying yields and production levels, hampers overall economic development. PFPV directly impacts food availability and stability, making it challenging for households to access a reliable food supply. This leads to increased vulnerability to undernourishment, hunger and related health issues, which ultimately hinder human capital development and reduce productivity. Accordingly, economic growth of developing countries is affected destructively. The results regarding the adverse effects of food production variability on economic growth of developing nations were also presented by Sahn & Von Braun (1987). The study also established that variability in production is responsible for the underdevelopment of developing countries.

Table 9

MM-QR Results of Economic Growth Model based on Food Utilization

DV = Per-Capita GDP (GDPPC)							
Variables	**Location**	**Scale**	**Q 0.10**	**Q 0.25**	**Q 0.50**	**Q 0.75**	**Q 0.90**
LFPR	0.02***	-0.02***	0.06***	0.04***	0.02***	0.00	-0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
GFCF	0.01	0.03***	0.04***	0.02*	0.01	0.04***	0.08***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
IDW	0.02***	0.00	0.02***	0.02***	0.02***	0.02***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
GI	-0.01***	0.00	-0.01**	-0.01**	-0.01***	-0.01***	-0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ARM	-0.03***	0.00***	-0.04***	-0.04***	-0.03***	-0.02***	-0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SSE	0.02***	0.00***	0.01***	0.01***	0.02***	0.02***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
M2	0.01***	0.00***	0.00**	0.01***	0.01***	0.02***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
TAX	0.12***	0.04***	0.06***	0.08***	0.11***	0.15***	0.19***
	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
CONSTANT	21.42***	2.155***	17.73***	19.73***	21.56***	23.33***	24.60***
	(0.36)	(0.26)	(0.69)	(0.49)	(0.35)	(0.33)	(0.39)
Observations	2,759	2,759	2,759	2,759	2,759	2,759	2,759

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source: Authors' computations

Regarding the impact of IDW the results of our study have shown a significant and positive impact of food utilization on economic growth. It recommends that for the economic growth of developing countries access to improved drinking water (IDW) is very essential. As improved drinking water improves health, lowers the chance of illness due to waterborne diseases. It results in increased labor productivity which leads to increased productivity of labor force. Due to health benefits achieved by the use of improved drinking water healthcare costs of the economy can be reduced. The resources which were previously invested on healthcare costs now can be allocated to the other economic activities that boost economic growth. These results of present study are in line with the results of previous studies (Hutton et al., 2004; Srinivasu & Rao, 2013; Purba & Budiono, 2019; Budiono & Purba, 2020). The positive role of IDW in promoting GDPPC of developing countries also supports by the attainment of Sustainable Development Goal 6. This goal pays great attention to the role of improved water and sanitation facilities for the achievement of sustainable economic development.

The above stated results are of great importance for the policymakers who intend to design policies that can stimulate investment in infrastructure, encourage labour force participation, lessen income inequality, enhance food security and improvement of financial system with a focus on achieving sustainable economic development.

5 Conclusions and Policy Recommendations

By using the panel data set for the period 1990-2020 the present study intended to identify how economic growth of developing countries can be boosted through agricultural exports and food security. Moreover, it identified the ways by which economic growth is hindered through income inequality. By employing the Methods of Moments Quantile Regression (MMQR), the research explored the prospects and problems which are faced by the developing countries while tackling food security and economic growth in order to enhance economic growth. The MMQR analysis was

employed to measure all four models of economic growth for each aspect of food security separately. The results of the analysis contributed significantly to understand the intricate relationship between food security and economic growth of developing countries. Particularly, by using GDPPC as a measure of economic growth the study initially concentrated on the first dimension of food security i.e. "Availability". APS (average protein supply) is used in the study as a proxy for food availability. According the results, economic growth is significantly increased by labor force participation rate (LFPR) and gross fixed capital formation (GFCF). Adequate food availability, as measured by average protein supply (APS), positively influences economic growth by promoting good health and productivity. On the other hand, income inequality (measured by the Gini index) and reliance on agricultural exports (ARM) have negative impacts on economic growth. Higher income inequality hampers human capital accumulation and reduces aggregate demand, while dependence on exports leads to unfavourable terms of trade and price volatility. Secondary school enrollment (SSE) positively impacts economic growth through human capital development and technological progress. Furthermore, financial development (represented by M2) and effective fiscal policies (reflected in tax revenue) positively contribute to economic growth. For our second model of food security, based on food access measured through PUN (prevalence of undernourishment), all the explanatory variables have depicted the same impact on GDPPC of developing countries as the first model of food security. Whereas according to our results, the effect of PUN (prevalence of undernourishment) on the economic growth of developing states is negative and statistically significant for almost all quantiles. It implicates that undernourishment in developing countries hinders economic growth by reducing labor productivity and exacerbating income inequality and poverty. In third model, based on food stability measured through PFPV (per capita food production variability) MMQR results have shown a significantly negative impact of PPFP on GDPPC of developing countries. Higher variability in per capita food production in developing countries is negatively correlated with economic growth (GDPPC), indicating that fluctuations in food production have a detrimental effect on economic progress. As far as the impact of IDW (People using at least improved drinking water services) is concerned, results of our empirical analysis have shown favourable relationship between food utilization and economic growth of developing countries. It suggests that access to improved drinking water (IDW) is vital for the economic growth of developing countries. These findings provide valuable insights for policymakers to design targeted interventions that promote labor force participation, investment in infrastructure, food security, reduced income inequality and financial system development, ultimately fostering sustainable economic growth and improved well-being in developing countries. Promoting food security to enhance economic growth, the role of ggovernment policies and programs can't be denied. To achieve this goal Asian Development Bank (2012) has suggested that implementation of policies such as food-based safety nets and social protection programs are essential. The present study suggests some policy implications for policy-makers of developing countries.

- To ensure long-term food security and to raise economic growth developing countries should enhance agricultural productivity through improvements in technology.
- In order to achieve sustainable economic growth as well as to be food secure these countries should reduce their agricultural exports and curtail their dependency on food imports.
- To deal with the problem of income inequality developing counties should opt the measures such as social safety nets and progressive taxation. So that the cutbacks in income inequality can boost the aggregate demand, contribute to the human capital accumulation and ultimately sustainable economic growth can be stimulated.
- The variations in the food production can be managed through the measures such as investing in water management and irrigation infrastructure.

Investments in water infrastructure should also be prioritized by the governments of developing countries so that the provision of improved drinking water can be ensured for the masses of the countries. As access to improved drinking water can enhance health, raises productivity and ultimately can positively contribute to the economic growth of developing nations.

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