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Climate Change and Food Security: Are Asian Economies Tracking Sustainable Development Goals?

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ABSTRACT

Sustainable Development Goals 2030 is a sustainable development track approved by the United Nations in 2015. All member countries are trying to attain these SDGs. Unfortunately, Asian countries are still far from this track. Achieving SDG 2 (zero hunger) under the shadow of climate change (SDG 13) requires an indispensable line of action for the developing world and, specifically, Asian countries. Food security is the first step to achieving SDG 2 with changing climate. This study investigates the probable footprints of climate change and other socioeconomic determinants on food security in 8 Asian food-insecure countries from 1990 to 2019. The study secrutinizes climate change and food security literature as they relate to an SDG-oriented policy agenda. The study results reveal that climate change and socioeconomic determinants substantially affect food security. The Panel Quantile Autoregressive Distributed Lag Model (PQARDL) outcomes illustrate that undernourishment prevalence (SDG 2.1.1) will likely be reduced due to increased agricultural productivity, food availability, and economic growth. However, this is compromised by the negative effects of greater variations in temperature and food supply. Increasing rainfall is likely to reduce the prevalence of undernourishment (SDG 2.1.1) in the long run. Contrarily, a temperature rise will exacerbate the prevalence of undernourishment (SDG 2.1.1). Based on the outcomes, comprehensive SDG-oriented policy recommendations have been put forward to realize the goals of SDG 2, SDG 8 and SDG 13 for Asian food-insecure countries.

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1. Introduction

The issues of climate change and food security gained momentum in 2015 after endorsing the Sustainable Development Goals (SDGs) by the United Nations. These seventeen SDGs cover economic, environmental, and social aspects of a sustainable future. Though SDG 2-ending hunger- has a pronounced significance, it encompasses access to sufficient, safe and nutritious food for all people at all time. secure and healthy population by 2030. Hunger leads to numerous health-related, human capital, environmental, and socioeconomic issues. Therefore, the success of other goals depends to some extent on achievement of SDG 2.

The effort to end hunger (SDG 2) is off track. In 2021, 957 million people experienced the painful condition of hunger, compared with 770 million in 2020. The prevalence of undernourishment has also increased during 2020, and it is estimated that about 10 per cent of the world population is undernourished. A 9 per cent prevalence of undernourishment or 480 million malnourished people was estimated in Asia in 2020. It seems complicated to realize the goal of zero hunger by 2030 because escalation in the prevalence of undernourishment is contingent on various underlying causes, such as climate change, slowdowns of economic activities, and conflicts (Black et al., 2008). The goal of zero hunger is viable through sustainable agricultural production, food security and low-cost nutritious food. Therefore, achieving food security is imperative to realizing SDG 2.

Food security can be defined as "when all people, at all times, have physical and economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life" (M. Ahmad, Iqbal, & Farooq, 2015). Food security has four pillars: availability, accessibility, stability, and utilization, and they depend on each other. However, affordable, nutritious food for all people is a basic necessity for a human being.

Food insecurity is officially measured by FAO’s Food Insecurity Experience Scale (FIES). The FIES provides information on access to sufficient and nutritious food at household and individual levels. It categorizes food insecurity as of moderate or severe. According to FIES estimates, 1.4 million people experienced moderate food insecurity, and an additional 1 million experienced severe food insecurity in 2020. Moreover, every third person did not have access to sufficient and nutritious food in 2020.

The two concepts of food insecurity and undernourishment complement each other. Underdeveloped countries face the burden of undernutrition, which is most prevalent among rural people (Pasricha & Biggs, 2010). Undernourishment is predominantly allied with malnutrition and directly affects labour productivity, human development and thereby economic growth . Commonly, undernourishment is a combined effect of food insecurity, inadequate health services and poor care (Gillani, Shafiq, Ahmad, & Zaheer, 2021). Thus, food security is an initial step to tackling the problem of hunger and undernourishment.

Of the 4.68 billion people living in Asia, and 54 per cent of the population is hungry, of which 9 per cent is undernourished. In addition, the prevalence of undernourishment was estimated in Asia, Central Asia, Eastern Asia, South-eastern Asia, Southern Asia and Western Asia as 23.7%, 14.1%, 23.2%, 30.7%, 24% and 6.3%, respectively, during 1990. Figure 1 shows the persistent decline in the prevalence of undernourishment from 1990 to 2019 in different parts of Asia, except in West Asia due to ongoing crises, conflicts and instability in countries such as Yemen and Syria.

The decline in hunger and undernourishment in Southern Asia, especially in Nepal, Pakistan and Sri Lanka, has been mainly attributed to economic development during the last decade. Reductions in undernourishment in China and India have been attributed to sustained long-term economic growth, better access to necessities and reduced regional income disparities. However, most Asian regions are far from achieving the goal of food security and zero hunger.

Food security depends primarily on agricultural production. Natural calamities heavily influence agricultural production as the climate is an essential input and determinant of agricultural output. Variations in temperature and rainfall have substantial impacts on agricultural production, farmers' income, inputs and outputs on domestic food prices, trade patterns, socioeconomic setups and ultimately, food security. Climate change has both positive and negative impacts. High and middle-altitude countries like Russia, Canada, Central Asia, and Northern Europe will enjoy the advantage of gaining arable land and longer growing seasons (Kiselev, Romashkin, Nelson, Mason-D'Croz, & Palazzo, 2013). Contrarily, climate change has adverse effects on parts of Asia and Africa, challenging low-income and developing countries with few resources to adapt to adverse effects of climate change. This is projected to be the case in South and Southeast Asia (Field & Barros, 2014).

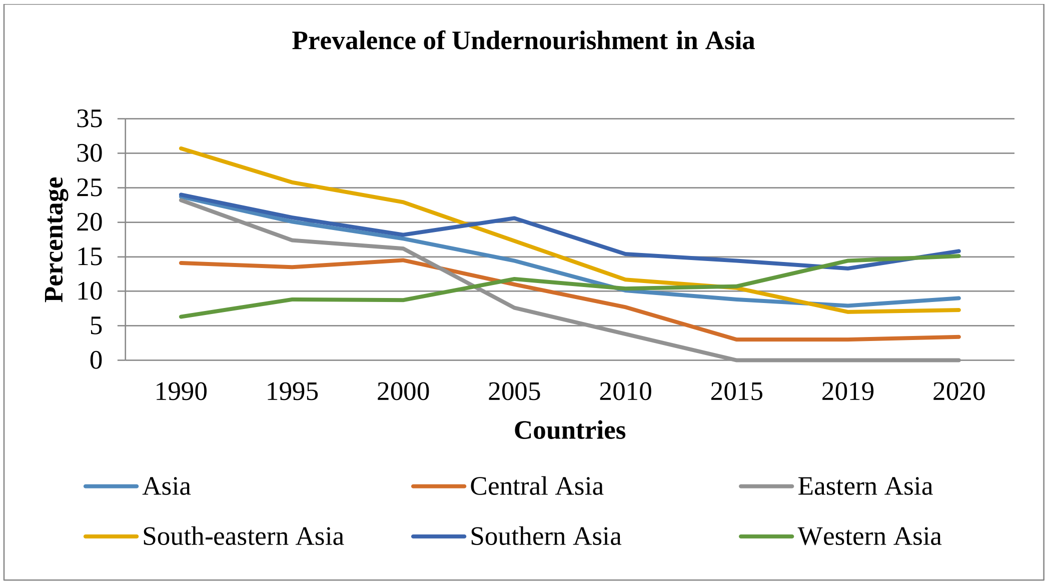

Figure 1: Prevalence of Undernourishment in Asia
Source: FAOSTAT (http://faostat.fao.org)

Moreover, it is projected that the temperature will likely increase by 2°C, and consequently, more intense heatwaves/stress and more erratic and extreme rainfall is projected for South Asian regions. The South Asian region is characterized by its unique topography and altitudinal variations. The United Nations Environment Program (2003) declared South Asia a disaster-prone area with natural hazards in the future (Thornes, 2002).

1.1 Climate-Induced Disasters in Asia (1970-2019)

According to World Meteorological Organization (2021), Asia has faced 3454 climate-related disasters from 1970 to 2019. 31% of all climate and flood disasters during that period took place in Asia. The total economic losses were estimated at 1.3 trillion US dollars from 1970 to 2019. Table 1 shows that China has been the top victim of these climate-related disasters. The economic losses accounted for US dollars 598 billion from 1970 to 2019 in China. Hence, climate disasters adversely affect Asia's economic, and livelihoods, impacting health, education, industry, services, and agriculture sectors.

Climate change has various impacts on agriculture (Downing, 1993), pests disease, and nutritional quality of crops, plant cells destruction, early grain filling stage of crops, flowering stages and eventually decline in crop production. Several studies investigated the impacts of climate change on different crops such as wheat (Tusawar I Ahmad, Khan, Soharwardi, Shafiq, & Gillani, 2021; Ali et al., 2017; Janjua, Samad, Khan, & Nasir, 2010; Shafiq, Gillani, & Shafiq, 2021; Siddiqui, Samad, Nasir, & Jalil, 2012; Trnka et al., 2019), rice (Akinbile, Akinlade, & Abolude, 2015; Ali et al., 2017; Van Oort & Zwart, 2018) and maize (Davenport, Funk, & Galu, 2018; Freduah et al., 2019; Waha, Müller, & Rolinski, 2013). These found adverse impacts of climate change on crop productivity.

Erratic rainfall and rising temperatures attributed to climate change affected wheat growth and yield adversely in southern China but positively in northern China from 1981 to 2019 (Tao et al., 2014). Rice production is under pressure due to the pronounced effects of climate change in tropical and sub-tropical areas of India (Kaur, 2017). In addition, food crop production is likely to reduce due to the erratic rainfall and temperature rise and increased food insecurity in South Asia (M. Hussain et al., 2020). Another study by (Kumar, Tokas, Kumar, Lal, & Singal, 2018) in India has also confirmed the adverse effects of climate change on agriculture production, food security, and India's nutritional status.

Table 1
Top climate disasters according to economic losses

Year	Disaster	Country	Economic Losses US dollar (billion)
1998	Flood	China	47.02
2011	Flood	Thailand	44.45
1995	Flood	Korea PDR	25.17
2008	Temperature Extreme	China	25.06
1994	Drought	China	23.72
2016	Flood	China	22.92
2010	Flood	China	21.10
1996	Flood	China	20.52
1991	Storm (Mireille)	Japan	18.76
2014	Flood	India	16.90

Source: World Meteorological Organization, (2021)

This paper investigates the association between food availability, accessibility, stability, economic growth (SDG 8), socioeconomic factors, and climate change on food security (prevalence of undernourishment) to achieve SDG 2 in food-insecure Asian countries. It has been observed that poor mental health, low performance in academic life and cognitive skills directly affects job performance and productivity (Gillani, Shafiq, & Ahmad, 2019). Therefore, with the significant importance of undernourishment in economics, there is a dire need to address this issue to achieve SDG 2 in Asian countries. Moreover, from the econometric results, we devise the policy framework for SDG 2 (food security), SDG 8 (economic growth) and SDG 13 (climate action) to decrease the prevalence of undernourishment in food-insecure Asian Countries.

The present study contributes to the literature by adding theoretical and applied aspects. Firstly, literature related to climate change and food security considers the determinants of each dimension separately and does not consider the effects of food availability, accessibility and stability on utilization (fourth dimension of food security) in Asian countries, which is a research gap. The study will fill this gap by analyzing three dimensions of food security on the prevalence of undernourishment by taking climate change as an influencing factor in food-insecure Asian countries. According to the researchers' knowledge, no study has done this before. The study also contributes to the existing methodologies by employing a panel of quantitative data sets. A quantile autoregressive distributed lag model (PQARDL) will be used, introduced by (Cho, Kim, & Shin, 2015). PQARDL is a median-based rather than mean based panel autoregressive model using standard least square methodology. A standard least-square line is estimated by assuming a normal distribution with zero mean and constant variance.

As in econometric literature, there are different series which exhibit non-normal behaviour and consist of outliers. PQARDL is considered robust for these data which exhibit non-normal and consist of outliers (Aslan, Ozsolak, & Doğanalp, 2021). The second section of the paper presents a comprehensive summary related to food security and climate change, the third section discusses methodological issues, data, results and discussion section explains the relevance of the results on the background of other studies. The last section summarizes the conclusions and policy implications of the study.

2. Literature Review

The global population is continuously increasing, and there will be 9 billion people in the next 28 years. Climate change and population growth need to be considered together as determinants of food production, water scarcity, food and nutritional security in low income developing countries.

2.1 Climate Change and Food Security

Daily and Ehrlich (1990) investigated the potential impacts of climate change on agricultural production, population and hunger around the globe. They applied stochastic-simulation technique to create projection for next 20-years. They found inverse relationship between grain production and hunger with different climate scenarios. The study predicted that if grain production cut in half than deaths due to starvation will rise fivefold. Climate change impacts will be smaller. If climatic conditions are favorable and population growth is greater than food production the deaths rates will be fourfold. Therefore, an effective policy framework is required to reduce the adverse impacts of climate change and a stable per capita food availability.

Nguyen (2002) reported that half of the population's food security depends on rice supply and production. The study found large changes in land and water availability due to climate change which leads to significant changes in rice production and growth in various regions of the world. The study suggested that a sustainable rice production under the global warming is required to ensure food security. For this purpose, adaptation to climate change and mitigation strategies should be followed and improved.

Ramasamy (2010) argued that climate change and food security as challenges for our world. The agriculture sector is vulnerable to droughts, floods and temperature, and climate variations can cause crop failure, forest fires, aqua life damages and livestock mortality: all these damages increase economic losses and food insecurity (T. I. Ahmad, Tahir, Bhatti, & Hussain, 2022). Hence, climate change is a significant threat to global and regional food security. M. Ahmad et al. (2015) explained the impact of climate change on household food security in Pakistan. They developed households' food security index for different agro-ecological areas of Pakistan. Household food security is closely related to climate change adaptation strategies, and households with climate change adaptation were found to be more secure. Food security status also rises with other contributing factors such as non-farm income sources, procession of livestock, education level, access to electricity, and crop diversification.

Reyer et al. (2017) unveiled various facts about the relationship between climate change and food security in Central Asia. The study concluded that food security is at risk due to heavy rain, diseases and pests, increasing competition for water resources, temperature-induced crop damages and population growth. The food security of the urban population is found to be more vulnerable than the rural population because they spend a large share of their income on food. Many countries of Central Asia are dependent on food imports, and fluctuations in food prices in the international market, trade bans and blockages could increase food insecurity in the region.

Ali et al. (2017) explored the impacts of various climate indicators on food security in Pakistan. The study found that maximum temperature has adverse effects on wheat yield, and maize, rice, sugarcane and wheat production are positively related to minimum temperature. The rainfall results revealed that it has positive effects on wheat production and an adverse impact on all maize, rice, and sugarcane production. The study also suggested that more heat-resistant high-yielding seed varieties are needed to improve the status of food security in Pakistan. Kumar et al. (2018) discussed the inverse relationship between climate change, food security and nutrition in India. The study concluded that temperature upsurges reduce crop production, and crop quality is negatively affected by erratic rainfall patterns. Therefore, reduced food production leads to food inflation, decreased purchasing capacity and increasing undernourishment in climate-vulnerable countries.

Extreme weather events are particularly associated with food security, such as drought, affecting food availability and accessibility and increasing the prevalence of undernourishment. A study (Memon, Aamir, & Ahmed, 2018) was conducted in the semi-arid desert area of Tharparker, Pakistan, and found widespread undernourishment in children and women due to climate variability and droughts. Climate hazards have also adversely affected access to food in delta regions such as Ganges-Brahmaputra-Meghna Delta in Bangladesh (M. S. Islam, Okubo, Islam, & Sato, 2022). Moreover, daily wagers' food security and unskilled labour are more vulnerable to floods in these regions. Climate change and extreme weather adversely affect food mobility from farms to the local and international markets, limit access, and create instability in the continuous supply of healthy and nutritious food in low-income countries such as most parts of Asia (Fanzo, Davis, McLaren, & Choufani, 2018).

Muttarak (2019) explored that Asian countries face dual burden problems of undernutrition and obesity in the face of climate change. The study found that climate change adversely affects the four dimensions of food security (availability, accessibility, stability and utilization). Moreover, climatic shocks such as floods and droughts alter adults' food choices from nutritious food to high caloric and obesity. In contrast, children will be fed low nutrient foods and suffer malnutrition and undernutrition. Moreover, children born during climate disasters are mostly expected to suffer undernourishment (Fuentes-Nieva & Seck, 2010).

Bocchiola, Brunetti, Soncini, Polinelli, and Gianinetto (2019) explored the relationship between climate change, agricultural production and food security in Nepal. They developed Nutritional Households Index to measure food security, and the study predicted that food security will decline by 49% by 2050. McMahon and Gray (2021) explained that South Asia is at risk for climate-induced undernutrition because of extreme weather shocks, the prevalence of undernutrition and the lack of proper sanitation facilities. The study found that extreme precipitation in the first 12 months of a children's life has an adverse and significant effect on height-for-age in the South Asian region. The results are more pronounced for households that do not have proper sanitation facilities and less educated women. The rise in temperature and children's health are inversely related in Pakistan. Hence, climate change and climate extremes are detrimental to the nutritional status of the South Asian region.

Chandio, Ozturk, Akram, Ahmad, and Mirani (2020) studied the relationship between climate change, crop production and food security in South Asian countries. The study found that carbon dioxide gas emissions and temperature adversely affect crop production by 0.32% and 1.93%. Contrarily, rainfall has a 0.52% positive effect on crop production in Asian countries. In addition, erratic rainfall adversely affects food production and threatens food security in South Asia (A. Hussain, Rasul, Mahapatra, & Tuladhar, 2016).

2.2 The Undernourishment and Economic Growth

Literature supports a close link between economic growth, food security and undernourishment in various regions, particularly in developing countries. Since economic growth directly affects food supply, dietary energy supply per capita, life expectancy ratio of female to male, secondary school enrollment of females, access to safe drinking water and subsequently child malnutrition (Gillani, Shafiq, Bhatti, & Ahmad, 2022; Smith & Haddad, 2002).

Babar, Muzaffar, Khan, and Imdad (2010) explored that socioeconomic factors play an essential role in determining primary school children's nutritional status in Pakistan from age 5-11. The study used cross-sectional data from 2005 and revealed that poor health could be attributed to many factors such as family size, illiteracy, female literacy rate, poverty and food insecurity in poor socioeconomic classes in Pakistan.

Ecker, Breisinger, and Pauw (2011) found a bidirectional relationship between social, economic, and nutritional status in developing countries at the micro and macro levels. The study explained that undernourishment impacts income generation capacity, low academic performance, disability, mortality, intergenerational illness, and vicious undernutrition (Black et al., 2008). The pre-harvest period and hunger season create irreversible temporary malnutrition in children. External shocks such as floods, droughts, and civil conflicts will slow economic growth, high food and non-food inflation, low investment in the human development sector at the macro level, and the nutritional status of households at the micro-level. Moreover, alone economic growth cannot reduce undernourishment and improve health standards. Therefore, socioeconomic factors, mitigating natural disasters and economic growth can bring down the rate of undernourishment.

Soriano and Garrido (2016) discussed the importance of economic growth in determining the rate of undernourishment in developing countries. The study used panel data set for 27 countries from 1991 to 2012. The study results revealed that economic growth and the rate of undernourishment are inversely related in the short and long run. Economic growth leads to reduced undernourishment and access to health services and drinking water; investment in education and health can improve food security and reduce the prevalence of undernourishment.

M. Islam (2020) explored the association between life expectancy at birth, adult literacy rate and economic growth for a panel of South Asian countries (Pakistan, Bangladesh, Nepal, Sri Lanka and India) for the period 2000 to 2016. The cointegration tests showed that these countries' adult literacy rate, economic growth and life expectancy have short term and long-term relationships. Bidirectional Causality between adult literacy and economic growth, adult literacy and life expectancy at birth and life expectancy at birth and economic growth has been found. Mohammad Saiful Islam (2021) explained the relationship between education, national income and undernourishment in Asian countries with the help of the Vector Error Correction Method and the Toda-Yamamoto Granger Causality Test. The study revealed that adult literacy has adverse effects on the undernourishment rate and will improve the health of Asian people. National income negatively affects undernourishment in the short run, but an insignificant role has been observed in the long run. Therefore, adult literacy helps improve human capital and, subsequently, a high economic growth rate in Asian countries.

3. Empirical Framework

3.1 Theoretical Model

Food can be acquired through domestic agriculture or foreign trade. Agricultural production depends on various inputs, and climate is one of them. Climate change has both positive and negative effects on agricultural production. Its adverse impacts on agricultural production have been documented mainly in developing countries. Some climate changes such as slow and steady rise in temperature, changes in amount, seasonality and predictability of rainfall, seasonal fluctuations, and greater frequency or intensity of extreme weather events can directly cause land degradation, desertification, soil erosion, aridity, water scarcity with resultant loss of agricultural land and arable land, and droughts causing deterioration in agricultural production and food security (M. M. Islam & Al Mamun, 2020; Lin et al., 2017). The links are shown in figure 2.

Biological, physical and socioeconomic factors indirectly affect crop production and food security through intensive land use and loss of soil nutrients. Moreover, 75% of the world's agricultural production is rain-fed, and reduced in rainfall directly affects crop production and food supply. Accordingly, climate change has the potential to threaten the food security in developing countries. In conjuction with factors such as rising population and failing economic growth. Hence, climate change poses a significant menace to sustainable development and eradication of hunger around the globe and specifically in food-insecure Asian countries.

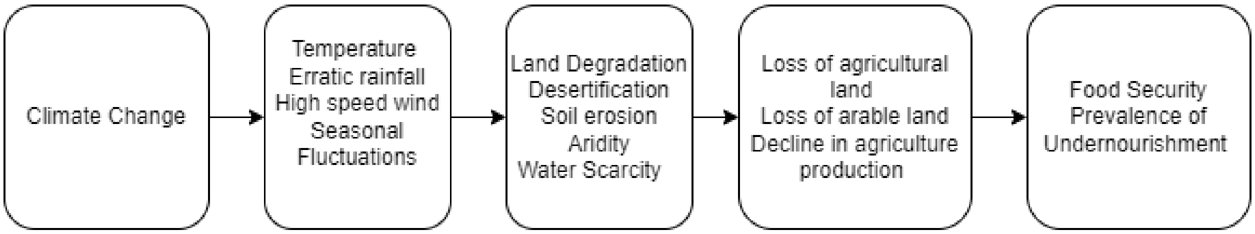

Figure 2

3.2 The Proposed Model

This paper aims to investigate the impact of dietary energy supply adequacy, gross domestic product per capita, food supply variability, agricultural land, rainfall, temperature on prevalence of undernourishment, which is the official indicator of Sustainable Development Goal 2 (eradicating hunger). The functional form of the proposed model is as follows:

$$PU = f(DE, PG, GDPPC, FSV, AG, RAI, TMP) \quad (1)$$

Here, PU symbolizes the prevalence of undernourishment, DE represents dietary energy supply adequacy, PG means population growth, GDPPC conveys gross domestic product per capita, Ag denotes agricultural land, FSV is food supply variability, RAI indicates yearly average rainfall, and TMP represents average annual temperature.

The equation of the proposed model is as follows:

$$PU = b_o + b_{DE}DE_{it} + b_{PG}PG_{it} + b_{GDPPC}GDPPC_{it} + b_{FSV}FSV_{it} + b_{AG}AG_{it} + b_{RAI}RAI_{it} + b_{TMP}TMP_{it} + e_{it} \quad (2)$$

Here,
b_0 is the intercept, b_{DE}, b_{PG}, b_{GDPPC},b_{FSV}, b_{AG}, b_{RAI} and b_{TMP} indicate slopes coefficients of DE, PG, GDPPC, FSV, AG, RAI and TMP, respectively. "i" represents cross-section, and "t" denotes time selected for the study.

4. Methodology
4.1 Data and Measurement of Variables

Table 2 briefly describes the selected variable and its respective data sources. The prevalence of undernourishment (PU) is measured in percentage and serves as a proxy for food security, and it shows that an individual consumes insufficient calories required for a healthy and active life. The dietary energy supply adequacy (DE) data is measured as a mean dietary energy requirement percentage indicates as a proxy of food availability. Annual population growth (PG) is taken as a percentage. GDPPC is gross domestic product per capita and is measured in the 2015 US dollar. This variable is taken as a proxy cast-off for economic growth. FSV is food supply variability (kcal/ per day/ capita) and the variations in food supply available to an individual. AG is agricultural land that acts as a control variable to measure the requirement of agricultural land for food security, and data is in the percentage of total land area. Yearly average rainfall (RAI) is measured in millimetre, and the average annual temperature is measured in Celsius degrees.

DE, GDPPC**,** FSV, AG and RAI are used with logarithmic transformation. The data relating to population growth, gross domestic production per capita, agricultural land, temperature, and rainfall is available in an annual series, while the prevalence of undernourishment and dietary energy supply is in three year averages; moreover, variations in the food supply measured in 5 year deviations. Data was collected from Food and Agriculture Organization (FAO) websites and World Bank Indicators. The countries selected for analysis are the Democratic Peoples' Republic of Korea (East Asia), India and Pakistan (South Asia), Cambodia and Lao Peoples' Democratic Republic, Timor-Leste (South-East Asia), Yemen and Iraq (Western Asia). These countries are selected based on Global Hunger Index (GHI, 2021) (Appendix A)

Table 2
Data and Measurement of Variables

Abbreviations	Operational Definition	Sources
PU	Prevalence of undernourishment (per cent)	FAO
DE	Dietary energy supply adequacy (percentage of mean dietary energy requirement)	FAO
PG	Annual population growth (per cent)	WDI
ƚGDPPC	Natural logarithm of gross domestic product per capita (constant 2015 US dollar)	FAO
FSV	Food supply variability (kcal/ per day/ capita)	FAO
ƚAG	Natural logarithm of agricultural land (as a percentage of total land area).	WDI
ƚRAI	Natural logarithm of yearly average rainfall (millimetres)	CKP
TMP	Yearly average temperature (Celsius degree)	CKP

Note: Food and Agriculture Organization (FAO), World Development Indicators (WDI), Climate Knowledge Portal (CKP)

4.2 Unit Root Test

It has been observed that time-series data have unit root property, and cross-section data is commonly known as cross-section dependency. Panel data combine time series and cross-section, therefore, they have both properties. A fundamental rule for further empirical investigation is that variables should be stationary at level or after taking the first difference. The cross-section independence unit root test advanced by (Pesaran, 2007) will be employed by considering the above arguments.

The basic equation of CIPS is as follows;

$$y_{it} = \emptyset_i + \acute{\rho} m_{it} + \mu_{it} \qquad (3)$$

Here y is a K× 1 regression vector, measured in time "t" and t = 1,2 …T, while "i" stands for cross-section. $\emptyset_i$ Indicates individual distress parameters, and ρ is a K× 1 vector of the parameter. μ_{it} is error term and assumes that residual term is cross-sectionally independent.

The variables of interest must be stationary at level or first difference, or mixed order of integration is required to employ QARDL. Therefore, the CIPS test will be employed to check the unit root problem.

4.3 Panel Quantile Autoregressive Distributed Lag Model

In 1978, Koneker and Bassett put forward the quantile regression process, it was applied to panel data analysis. Cho et al. (2015) and Mensi, Shahzad, Hammoudeh, Hkiri, and Al Yahyaee (2019) used the technique of QARDL for various variables. This method provides long-run and short-run relationships between the variables. The QARDL technique is more beneficial in the presence of a non-normal distribution of data and the presence of outliers.

Therefore, the study employed PQARDL to investigate the relationship between the prevalence of undernourishment, inflation, gross domestic product per capita, rainfall and temperature.

Suppose conditional quantile regression for variable z_i (response variable) is as follows:

$$Q_{zi}\ (\tau|y_i) = y_i^T\beta_\tau \quad (4)$$

The process of development for panel quantile autoregressive distributed lag is as given:

$$Q_{zi}\ (\tau_k|\gamma_i, y_{it}) = \gamma_i(\tau_k) + \sum_{j=1}^{p}\gamma_j\,(\tau_k)z_{it-j} + \sum_{l=0}^{q}\beta_l\,(\tau_k)y_{it-l}^T \quad (5)$$

Here, y is a vector of explanatory variables, i= 1, 2…N; and t = 1,2, …,T and k = 0.05,…, 0.95. γ_i Indicates intercept for *i* cross-section, γ_j represents slope coefficient of lagged response variable (z), β_l symbolizes slope coefficient of a vector of explanatory variable (y).

The response variable can be estimated as follows:

$$Z_{it} = \gamma_i(\tau_k) + \sum_{j=1}^{p}\gamma_j\,(\tau_k)z_{it-j} + \sum_{l=0}^{q}\beta_l\,(\tau_k)y_{it-l}^T + \mu_{\,it}(\tau_k) \quad (6)$$

Here, i= 1, 2…N; and t = 1,2, …,T

As mentioned earlier, the equation (5) can be transformed into a panel quantile autoregressive distributed lag model (PQARDL). The residual term $\mu_{\,it}(\tau_k)$ can be calculated with the help of $Z_{it} - Q_{zi}\ (\tau|y_i)$ and now we get

$$Z_{it} = \gamma_i(\tau_k) + \sum_{j=0}^{q-1}V_{it-j}\,\emptyset_{it,j}(\tau_k) + \acute{Y}_{it}\alpha_0(\tau_k) + \sum_{l=0}^{p}\vartheta_{it,l}\,(\tau_k)Z_{it-l} + \mu_{\,it}(\tau_k) \quad (7)$$

Here, i= 1, 2…N; and t = 1,2, …,T

$\alpha_0(\tau_k) : \sum_{l=0}^{p}\vartheta_{it,l}\,(\tau_k)$, $V_{it} : \Delta Y_{it}$ and $\emptyset_{it,j}(\tau_k) : -\sum_{i=j+1}^{p}\vartheta_{it,m}\,(\tau_k)$ for $\tau \in$ (0, 1)

The minimization problem solved by (Koenker, 2004) that may occur in the case of using various quantiles such as 0.05,…,0.95 and can be written as follows;

$$argmin(\gamma,\beta)\sum_{k=1}^{K}\sum_{t=1}^{T}\sum_{n=1}^{N}\omega_k\,\rho_{\tau k}\,\{z_{it} - \gamma_i - \sum_{j=0}^{p}\acute{V}_{it}\,\emptyset_{it,j}(\tau_k) + \sum_{i=j+1}^{p}\theta_{it,l}\ Z_{t-j} \quad (8)$$

This term is useful in the process of PQARDL and is given as

$$Q_{zi}\ (\tau_k|.) = \gamma_i(\tau_k) + \aleph(\tau_k)\left(Z_{t-1} - \acute{Y}_{t-1}\,\beta\,(\tau)\right) + \sum_{j=1}^{p-1}\theta_j\,(\tau_k)Z_{it-j} + \sum_{l=0}^{q-1}\varphi_l(\tau_k)\ \Delta y_{it-l}^T \quad (9)$$

Here,

$\epsilon(\tau_k) = \sum_{j=1}^{p}\theta_j\,(\tau_k)Z_{it-j} - 1,\ \ \varphi_0(\tau_k) = \partial(\tau_k) + \emptyset_0(\tau_k)\,, \theta_j\,(\tau_k) = -\sum_{i=j+1}^{p}\theta_i\,(\tau_k)$ and

$$\varphi_l(\tau_k) = -\sum_{i=j+1}^{p}\emptyset_i\,(\tau_k)$$

The coefficients of the long and short run in equation 8 will vary across the quantile or quantile dependent. Lastly, the Wald test will be applied to all long and short-run coefficients that help calculate asymmetric effects.

5. Results and Discussion

5.1 An Overview of Selected Variables

Figure 3 shows that the prevalence of undernourishment declined in Cambodia, India, Lao PDR, Pakistan, and Timor-Leste. Prevalence of undernourishment was high in Korea PDR, Iraq and Yemen during the study period (1990-2019) due to various political and economic factors, such as inflation, currency crisis, and conflicts. Undernutrition increased in Yemen since 2015 due to disputes, economic downturn, destruction of basic health facilities and absence of social protection networks. In addition, dietary energy supply in Korea PDR, Iraq and Yemen also decreased in the same period (figure 4).

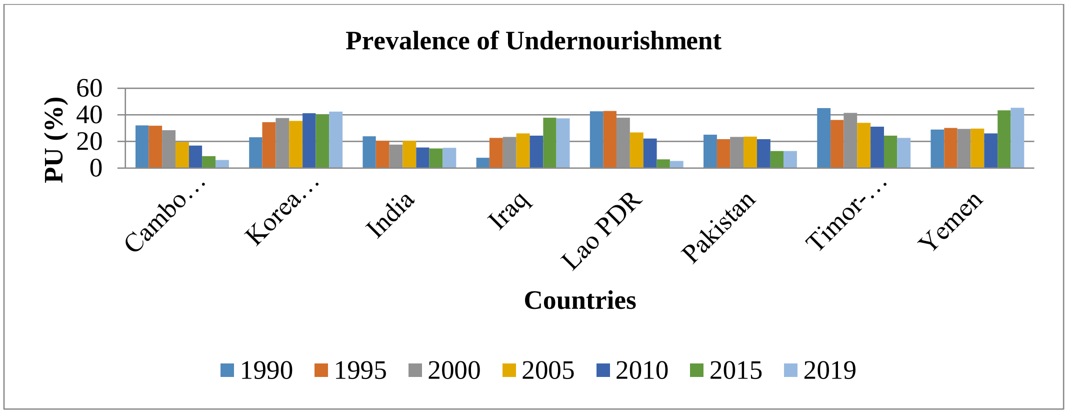

Figure 3: Prevalence of Undernourishment
Source: FAOSTAT (http://faostat.fao.org)

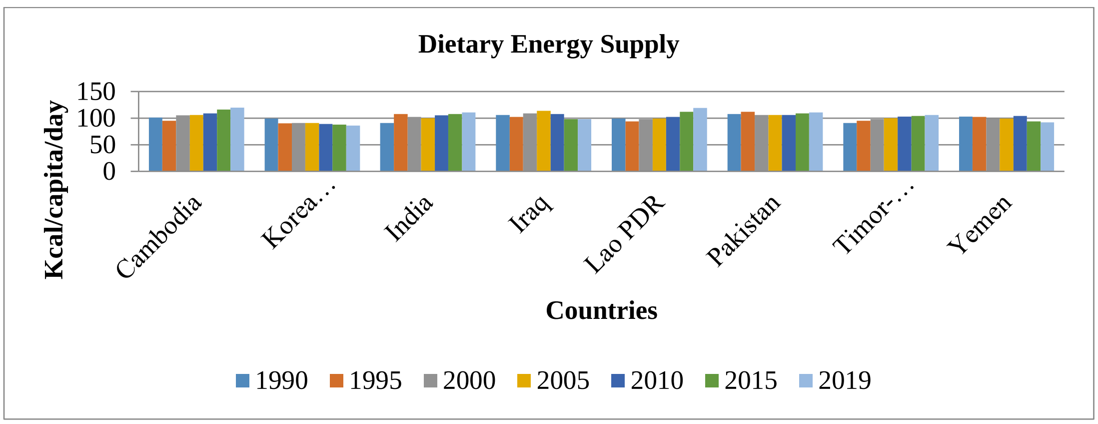

Figure 4: Dietary Energy Supply
Source: FAOSTAT (http://faostat.fao.org)

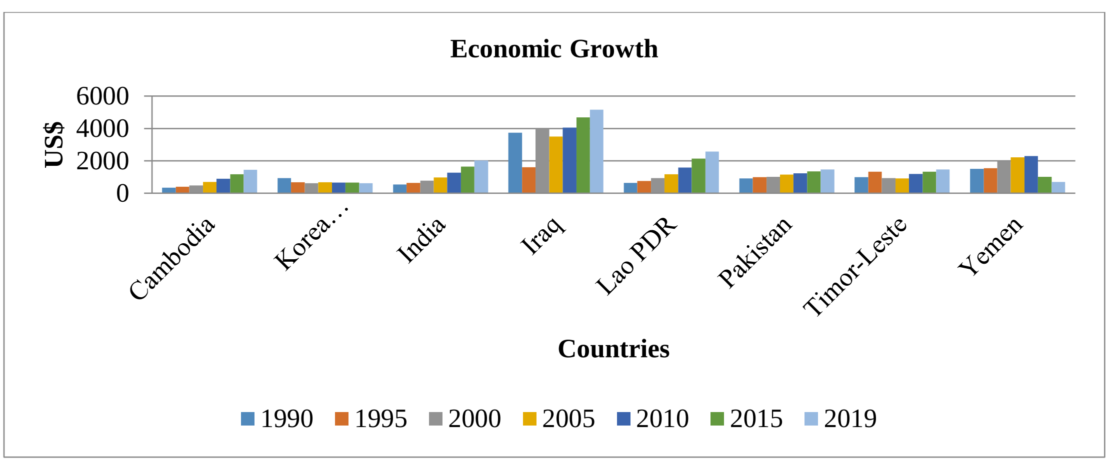

Figure 5: Economic Growth
Source: FAOSTAT (http://faostat.fao.org)

Trends in economic growth (Figure 5) show upward surges except for Korea PDR and Yemen. It confirms the arguments presented in the literature review that economic growth and food insecurity are inversely related. Strong economic growth brings food and nutritional security when keeping other variables constant such as political instability, civil conflicts and climate change. Although population growth (Figure 6) is considered a big dilemma in developing countries, the fact is quite interesting. All selected countries reduced population growth from 1990 to 2019.

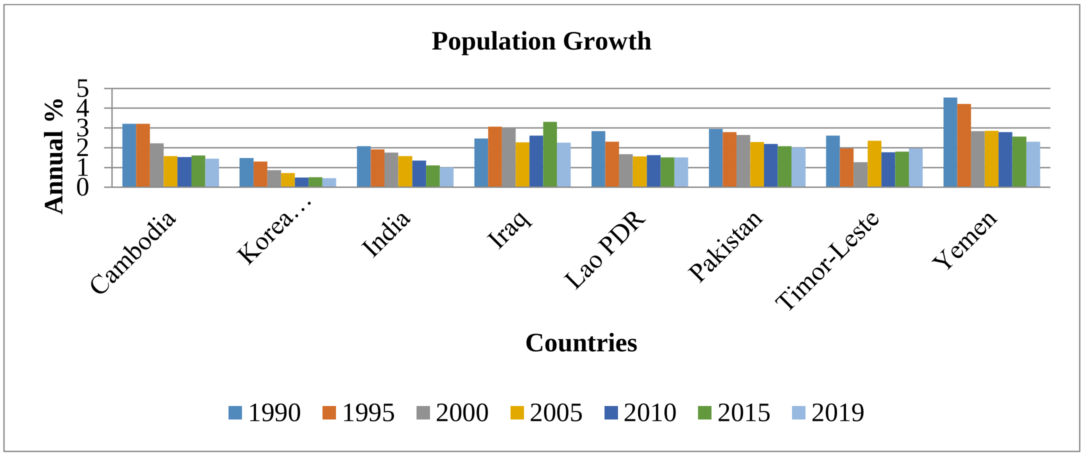

Figure 6: Population Growth
Source: FAOSTAT (http://faostat.fao.org)

5.2 Descriptive Statistics

Table 3 shows that the averages of all the variables are greater than the standard deviation, which means the data is scattered. The distributions of UP, DE, AG, RAI, and TMP are negatively skewed, indicating that black swan events have occurred in the history of these countries.

Table 3
Descriptive Statistics

	Mean	Std. Dev.	Skewness	Jarque-Bera	Probability	Obs.
UP	27.08750	9.932	-0.0600	4.788***	0.091232	240
ǂDE	4.621615	0.073864	-0.174235	3.176464	0.204286	240
PG	2.091756	0.886741	0.521084	17.122***	0.000191	240
ǂGDPPC	7.054931	0.586401	0.565801	12.957***	0.001536	240
ǂFSV	3.670002	0.750096	0.373858	6.650**	0.035965	240
ǂAG	3.318433	0.579769	-0.60174	14.913***	0.000578	240
ǂRAI	6.525078	0.961611	-0.460564	30.518***	0.000000	240
TMP	21.80275	6.179218	-1.883554	192.053***	0.000000	240

Note: ǂ denotes variable is in natural logarithm, ***,**,* denotes significant at 1%, 5%, and 10% significance level, respectively.

5.3 Unit Root Test

The next preliminary step is finding the unit root and order of integration between these variables. For this purpose CIPs unit root test, introduced by Pesaran (2007), is applied, results are shown in Table 4. UP, DE, PG and AG are stationary at the first difference I(1), while GDPPC, FSV, RAI and TMP are stationary at level I(0). It shows mixed order of integration and a clue to apply an autoregressive distributed lag model to these Asian food-insecure countries.

Table 4
Unit Root Test

Variables	CIPS I(0)	CIPS I(1)
UP	-0.685	-3.058***
ǂDE	-0.976	-4.172***
PG	-0.318	-3.273***
ǂGDPPC	-1.737**	-3.772***
ǂFSV	-1.909***	-4.654***
ǂAG	-0.882	-4.710***
ǂRAI	-4.752***	-6.120***
TMP	-3.755***	-6.120***

Note: ǂ denotes variable is in natural logarithm, ***,**,* denotes significant at 1%, 5% and 10% level of significance, respectively.

5.4 Panel Quantile Autoregressive Distributed Lag Model (PQARDL)

The PQARDL results are calculated in two steps; firstly, long-run outcomes are taken by employed PQARDL then the error correction term is developed from this long-run equation. After that, short-run results are estimated with the help of the error correction term and the differenced variables.

5.4.1 Long-Run Dynamics

The long-run estimates at 0.50 quantile or median are in Table 5, indicating that DE, PG, GDPPC, AG, and RAI negatively affect PU. In comparison, FSV and TMP increase the prevalence of undernourishment in selected countries. More specifically, the availability of food (DE) adversely affects the prevalence of undernourishment (PU), and its contribution to this model is latent. A 1% decrease in food availability increases the prevalence of undernourishment by 116 %.

Table 5
Long-Run Equilibrium

Dependent Variable: Prevalence of Undernourishment				
Variables	**Co-efficient**	**Stand Error**	**t-Statistics**	**P-Value**
ǂDE(τ)	-116.2358***	8.428586	-13.79067	0.0000
PG(τ)	-1.094977	0.664038	-1.648967	0.1005
ǂGDPPC(τ)	-2.682138***	0.870673	-3.080536	0.0023
ǂFSV(τ)	1.289236**	0.635563	2.028496	0.0437
ǂAG(τ)	-5.803706***	1.092081	-5.314357	0.0000
ǂRAI(τ)	-4.392430***	0.843844	-5.205265	0.0000
TMP(τ)	0.454310***	0.073447	6.185580	0.0000
C(τ)	619.3994	30.70440	20.17299	0.0000

Note: ǂ denotes variable is in natural logarithm, ***,**,* denotes significant at 1%, 5%, and 10% significance level, respectively.

Insufficient food supply (DE) can make these countries vulnerable to food insecurity. Reduction in food production and increase in population will have combined effects on food prices and subsequently exacerbate the prevalence of undernourishment (PU). The contribution of population growth (PG) is negative but insignificant in achieving food security; table 2 provides evidence of this estimate. Asia is a mixed picture of low and high-income countries; therefore, economic growth (GDPPC) can play an essential role in reducing the prevalence of undernourishment (PU), as estimated results support this argument. There is a negative association between economic growth (GDPPC) and the prevalence of undernourishment (PU), as expected that income increases always play a significant role in raising the standard of living and health standards (M. S. Islam, 2021) The results are in line with Soriano and Garrido (2016), who found an inverse relationship between economic growth (GDPPC) and the rate of undernourishment (PU) in developing countries. The estimates revealed that a 1% increase in economic growth (GDPPC) would reduce the prevalence of undernourishment (PU) or increase food security by 27%. Literature also provides evidence that economic growth in a country raises the demand for more nutritious food, domestically produced or through trade. Economic access helps in boosting economic growth. Therefore, more equitable income distribution is required to reduce undernourishment in the poor section of the population.

The variations in food supply raise the prevalence of undernourishment (PU). Any disruption in food supply can create dietary energy inadequacy in a country, and resultantly, undernourishment will exacerbate since food supply is an aggregate of domestic production, imports, and stock variations and minus exports. The change in these factors, especially in domestic production and imports, will significantly change the food supply and stability. Food import dependency will bring large variations in food stability. It is to be noted that food supply variations occur due to the abnormality and instability of food supply in the domestic market due to the political, economic and climatic factors. Climate hazards, political unrest, civil conflicts, and financial space to import food contribute to food supply variations. According to Belloumi (2014), "food stability refers to the situation in which food is periodically available in the domestic market so that it also contributes to nutritional security". A sufficient and consistent food supply reduces the prevalence of undernourishment. As in the case of selected countries, the results revealed a positive and significant relationship between FSV and PU; mathematically, a 1% increase in food supply variability (FSV) will increase the prevalence of undernourishment (PU) 13%. The contribution of agricultural land in achieving food security and reducing undernourishment prevalence is also significant, and it shows that a 1% increase in agricultural land will increase 58% food security or reduce the prevalence of undernourishment.

The estimated results of climatic variables are in favour as the study hypothesized means it is expected that rainfall will help reduce the prevalence of undernourishment (PU) by increasing food production and increasing agricultural gross domestic product in selected countries. A 1% increase in annual rainfall will decrease the prevalence of undernourishment (PU) by 44%, and these long-run estimates revealed that rain contributes significantly to achieving food and nutritional security. The results are consistent with a study in South Asia (Chandio et al., 2020) and (Ben Zaied & Ben Cheikh, 2015) and changes in average temperature (TMP) and rainfall (RAI) will also affect the food security of Asian countries by 2030 (Padgham, 2009). The temperature estimates show that temperature contributes to increasing the prevalence of undernourishment (PU) by damaging crop production, reducing food availability, and food inflation in selected countries. A 1% increase in annual average temperature will increase the prevalence of undernourishment (PU) by 45%, and it will deteriorate the status of food security and raise the rate of undernourishment in the long run. The adverse effects of temperature were found to be more pronounced than the positive effects of rainfall and become a threat to Asian countries due to the low adaptability of climate change (Guiteras, 2009).

5.4.2 Short Run Dynamics

The short-run dynamics are further divided into two parts: results are without country specification (table 6), and selected countries are incorporated in second estimates, as shown in table 7. Table 6 shows that food availability, population growth and income level significantly play their role in the short-run with one lag. The error correction term is also negative and significant, showing that the model is convergent and will converge towards its long-run equilibrium with a speed of 4%. In contrast, table 7 depicts the picture of short-run equilibrium with country specification effects and more lags in population growth. With one lag, population growth has adverse effects, while two lags positively affect food security, and this short-run model is significant for Cambodia and Lao PDR. In addition, the error correction term has improved after adding lags, and now the speed of convergence is 7% greater than before.

Table 6
Short Run Dynamics

Dependent Variable: Prevalence of Undernourishment				
Variables	**Co-efficient**	**Stand Error**	**t-Statistics**	**P-Value**
D(ǂDE(-1))***	-21.82899	8.206637	-2.659919	0.0084
D(PG(-1))***	-2.208774	0.531049	-4.159267	0.0000
D(ǂGDPPC(-1))**	-1.661593	0.738559	-2.249778	0.0255
D(ǂFSV)	-0.005672	0.229478	-0.024718	0.9803
D(ǂAG)	-4.102516	9.256299	-0.443213	0.6581
D(ǂRAI)	-0.340649	0.566377	-0.601453	0.5482
D(TMP)	0.235614	0.201141	1.171388	0.2427
ECM(-1)*	-0.044425	0.025304	-1.755646	0.0806
C***	-0.339953	0.093338	-3.642164	0.0003

Note: ǂ denotes variable is in natural logarithm, ***,**,* denotes significant at 1%, 5%, and 10% significance level, respectively.

Table 7
Short Run Dynamics with Country Specification Effects

Dependent Variable: Prevalence of Undernourishment				
Variables	**Co-efficient**	**Stand Error**	**t-Statistics**	**P-Value**
D(ǂDE(-1))	-15.47506	13.46914	-1.148927	0.2520
D(ǂDE(-2))	1.409093	4.481095	0.314453	0.7535
D(PG(-1))***	-3.661686	1.145738	-3.195919	0.0016
D(PG(-2))***	2.841414	0.774328	3.669520	0.0003
D(ǂGDPPC(-1))	-0.230268	0.780981	-0.294844	0.7684
D(ǂGDPPC(-2))***	-2.480908	0.803615	-3.087187	0.0023
D(ǂFSV)	0.112603	0.206881	0.544290	0.5869
D(ǂAG)	-6.168247	7.108046	-0.867784	0.3866
D(ǂRAI)	-0.709042	0.543816	-1.303828	0.1938
D(TMP)	0.019365	0.195230	0.099189	0.9211
ECM(-1)***	-0.073064	0.027777	-2.630403	0.0092
COUNTRY="Cambodia"*	-0.580582	0.307327	-1.889133	0.0603
COUNTRY="India"	-0.236508	0.253700	-0.932237	0.3524
COUNTRY="Iraq"	0.230234	0.288930	0.796850	0.4265
COUNTRY="Korea(DPR)"	0.131051	0.353636	0.370582	0.7113
COUNTRY="Lao People's Democratic Republic"***	-0.871508	0.335835	-2.595052	0.0102
COUNTRY="Pakistan"	-0.202339	0.216092	-0.936353	0.3502
COUNTRY="Timor-Leste"	-0.281969	0.219785	-1.282929	0.2010
COUNTRY="Yemen"	-0.168687	0.232493	-0.725560	0.4690

Note: ǂ denotes variable is in natural logarithm, ***,**,* denotes significant at 1%, 5%, and 10% significance level, respectively.

5.4.3 Validity of Model

The advantage of QARDL is that it provides position-specific behaviour of coefficients at different quantiles. The quantile process coefficients graph shows the change in coefficient due to the change in quantiles. It also explains how marginal effects change in the long run because of the changing position of the data in specific independent variables. This study used 20th, 40th 60th, 80th and 90th quantiles for brevity at 95% confidence level.

Figure 7 is based on the estimated results from long-run QARDL, which provides evidence that all the estimated long-run coefficients lie between 95 % confidence level, which validates the PQARDL. As we can see, food availability decreases from the 20th to the 60th quantile; after that, it shows an increasing trend till 90th quantile in the long run. The agricultural land also has decreasing trend but during all the quantiles except the 40th to 60th quantile. A decline can be seen in the population growth variable from 20th to 40th quantile, and its behaviour is almost stable in the long run. The quantile process for economic growth, in the long run, is constant during the 20th to 40th quantile; a sharp increase in GDPPC can be observed until the 60th quantile and a slight decline in the remaining quantiles. Food supply variability has an increasing trend throughout the quantiles; in contrast, temperature shows an increasing trend till 60th quantile, then it tends to slight decline for this model. The long-run changes in rainfall show that rainfall decreases during 20th to 40th quantile, and after that, it increases till 60th quantile and almost constant trend till 90th quantile.

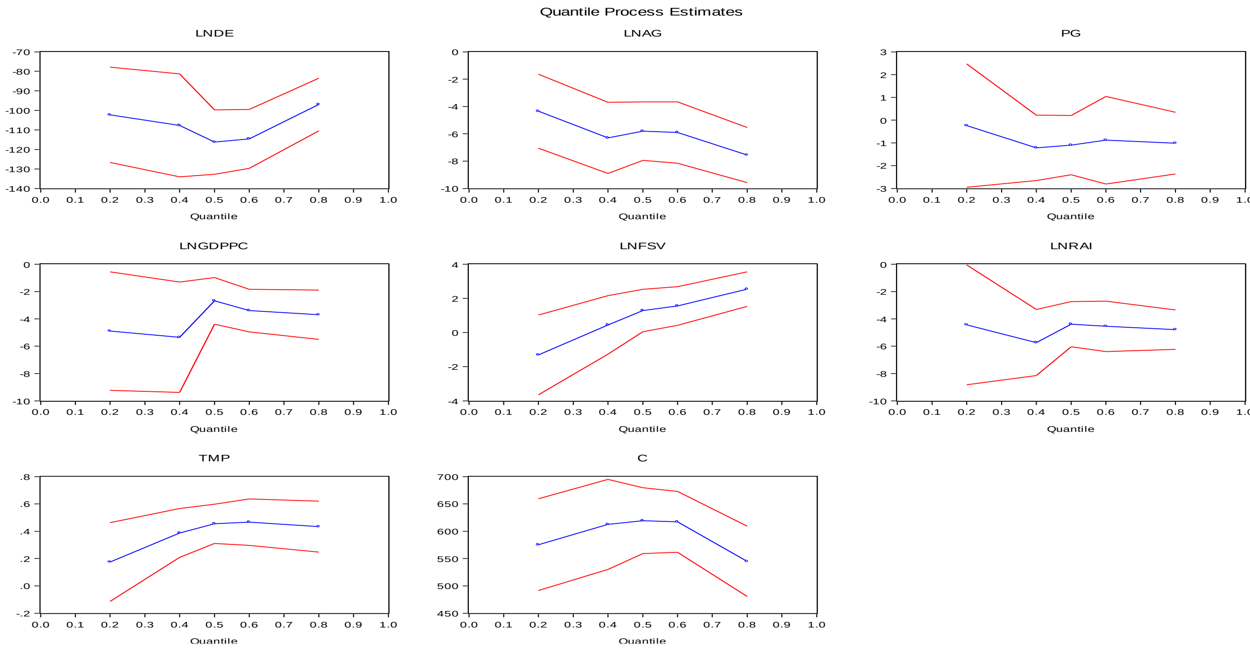

Figure 7: Long run Quantile Process Estimates

The quantile process for speed of adjustment term is shown in figure 8, ECM is stable between 40th to 60th quantile, and after that, it tends to rise till 90th quantile at 95% confidence level. It means that in the long run speed of adjustment will be increased, and the model will converge towards its equilibrium more speedily.

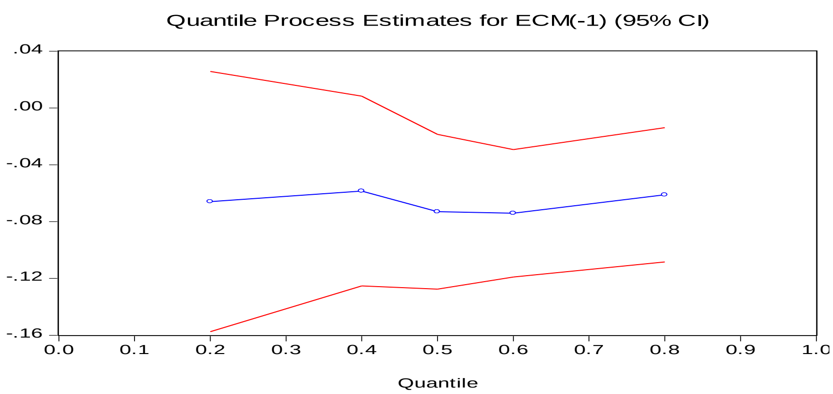

Figure 8: Quantile Process for Error Correction Term

5.4.4 Walds' Test

It is worthwhile to check the asymmetrical impact of food availability, population growth, economic growth, food stability, agricultural land, rainfall and temperature on food security or the prevalence of undernourishment. The present study uses the Wald test to check the significance of long-run coefficients at the median or 50th quantile.

Table 8
Wald Tests' Results

Variables	Chi-square (p-value)
ǂDE(τ)	190.18*** (0.000)
PG(τ)	9.49*** (0.002)
ǂGDPPC(τ)	2.72* (0.099)
ǂFSV(τ)	4.11** (0.042)
ǂAG(τ)	28.24*** (0.000)
ǂRAI(τ)	27.09*** (0.000)
TMP(τ)	38.26*** (0.000)

Note: ǂ denotes variable is in natural logarithm, ***,**,* indicates significant at 1%, 5% and 10% level of significance, respectively.

For this purpose, three tests (t-statistics, F-Statistics and Chi-square) under the Walds test have been used. All long-run variables except gross domestic product per capita in the three described tests are significant. In contrast, GDPPC is significant at 10% under the Chi-square test. It can be concluded that all the specified variables significantly contribute to achieving the goal of SDG 2 in selected countries.

6. Conclusion and Policy Recommendations

The present study investigated the long-run and short-run effects of food availability, economic growth, population growth, food stability, agricultural productivity, rainfall and temperature on food security. The study is based on a panel of eight Asian food-insecure countries, and the period is from 1990 to 2019. The long-run equilibrium association revealed that food availability, economic growth, food stability, rainfall, and temperature significantly determine food security in selected countries. Empirical estimations demonstrate that the prevalence of undernourishment is likely to reduce if an increase in dietary energy supply adequacy, gross domestic product per capita and agricultural productivity in these countries. In contrast, the prevalence of undernourishment will escalate with the expansion in food supply variations and rise in annual average temperature. Rainfall has a positive association with agricultural productivity and food availability; subsequently, it will have an adverse effect on the prevalence of undernourishment. Contrarily, global warming effects are prominent worldwide; therefore, a temperature rise will adversely affect food security by reducing crop yields, rising food prices and lowering economic access.

Undoubtedly, climate change alters social, economic, political, geographical and nutritional paths, leading policymakers to devise environmental-friendly policy frameworks. Firstly, food security (SDG 2) is directly linked with food availability; therefore, there is a need to take necessary steps to ensure all-time food availability. In this stance, domestic production can be increased by investing in the agriculture sector, developing high-yielding climate resistance varieties, efficient use of existing irrigation systems, improving the irrigation system, renovating existing water bodies and constructing more water reservoirs, and access to electricity for farmers, installation of solar systems can help in this regard.

Secondly, the agriculture sector contributes to carbon emissions; therefore, environment-friendly agriculture research and practices such as organic fertilizers and pesticides be introduced in these food-insecure Asian countries for healthy food production and nutritional security. Thirdly, the growing role of Information and Communication technologies can play a vital role in developing the agriculture sector. Weather-related information can be communicated to farmers through online programs and seminars. Fourthly, economic growth (SDG 8) is obligatory for a sustainable future but not at the cost of environmental degradation. There is a need to employ environment-friendly or low-carbon technologies in agricultural, industrial and service sectors, such as wind turbines, biomass heating, ground source heat pumps, solar hot water and solar photovoltaics. Fifthly, there is an utmost need to redistribute income and reduce income disparities to raise the purchasing power of people and economic access and reduce undernourishment in poor segments of society in food-insecure Asian countries.

Sixthly, undernourishment (SDG 2.1.1) is a multidimensional concept, and various complex factors are involved in this phenomenon. But malnutrition in children (under five years of age) has far-reaching effects on human capital formation in a region, particularly in South Asia. Large-scale development plans may be less effective in reducing the prevalence of undernourishment (SDG 2.1.1). However, low-cost, effective projects such as access to water and sanitation facilities at the community level, provision of supplements and vaccination against various diseases will reduce undernourishment and malnutrition in children.

The present study is based on Asian countries, however, further research is needed for an in-depth analysis of climate change effects on food security by considering other indicators of food security and with an extended panel of countries around the world.

Authors Contribution
Fahmida Zahid: main idea, draft and econometric analysis
Uzma Hanif: review and critical analysis
Faiza Javed: editing

Conflict of Interests/Disclosures
The authors declared no potential conflicts of interest w.r.t the research, authorship and/or publication of this article.

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Appendix 1

Global Hunger Index GHI 2021.
The Global Hunger Index was developed by International Food Policy Research Institute (IFPRI) to estimate hunger around the globe. This index is based on 100 scores.

Table 9

Score	Status
GHI = 0	Zero hunger
GHI<10	Low hunger
10<GHI>20	Moderate hunger
20<GHI>35	Sever hunger
35<GHI>50	Alarming condition of hunger
50<GHI>100	Extremely hunger

Table 10
Overview of the Selected Variables

Country	1990	1995	2000	2005	2010	2015	2019
Prevalence of Undernourishment (%)							
Cambodia	32.10	31.90	28.50	19.60	16.90	8.90	6.20
Korea (PDR)	23.30	34.60	37.70	35.50	41.20	40.30	42.40
India	23.80	20.50	17.60	20.60	15.40	14.70	15.30
Iraq	7.90	22.60	23.50	26.00	24.50	37.80	37.50
Lao PDR	42.80	43.00	37.90	26.90	22.30	6.70	5.30
Pakistan	25.10	21.80	23.40	23.70	21.70	12.80	12.90
Timor-Leste	45.20	36.20	41.60	34.00	31.20	24.50	22.60
Yemen	28.90	30.30	29.50	29.60	26.20	43.40	45.40
Dietary Energy Adequacy							
Cambodia	101.00	95.00	105.00	106.00	109.00	116.0	120.0
Korea (PDR)	99.00	90.00	91.00	91.00	89.00	88.00	86.00
India	91.00	108.00	102.00	100.00	105.00	108.00	111.00
Iraq	106.00	102.00	109.00	114.00	108.00	98.00	98.00
Lao PDR	99.00	94.00	98.00	99.00	102.00	112.00	119.00
Pakistan	108.00	112.00	106.00	106.00	106.00	109.00	111.00
Timor-Leste	91.00	95.00	98.00	100.00	103.00	104.00	106.00
Yemen	103.00	102.00	99.00	99.00	104.00	94.00	92.00
Economic Growth							
Cambodia	341	393	486	696	892	1163	1440
Korea (PDR)	925	674	611	668	647	650	615
India	544	631	773	973	1270	1639	2013
Iraq	3741	1594	4008	3494	4052	4688	5154
Lao PDR	634	752	923	1172	1584	2135	2573
Pakistan	918	1001	1021	1157	1223	1339	1468
Timor-Leste	984	1324	941	919	1186	1333	1467
Yemen	1511	1548	1982	2222	2296	1006	699
Population Growth							
Cambodia	3.21	3.22	2.23	1.57	1.53	1.60	1.44
Korea (PDR)	1.48	1.30	0.86	0.71	0.49	0.50	0.45
India	2.07	1.91	1.76	1.57	1.35	1.11	1.01
Iraq	2.46	3.07	3.00	2.28	2.61	3.31	2.25
Lao PDR	2.84	2.30	1.67	1.56	1.62	1.51	1.51
Pakistan	2.95	2.79	2.64	2.29	2.19	2.08	2.02
Timor-Leste	2.61	1.97	1.27	2.36	1.77	1.8	1.96
Yemen	4.54	4.21	2.84	2.86	2.79	2.57	2.30

Source: FAOSTAT (http://faostat.fao.org)