Rising Population and Food Insecurity Linkages in Pakistan: Testing Malthusian Population Growth Theory

Ahmad, Khalil and Ali, Amjad

Ph.D Scholar at National College of Business Administration and Economics, Lahore., Assistant Professor, Department of Economics, University of the Punjab, Lahore.

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Khalil Ahmad
Ph.D Scholar at National College of Business Administration and Economics, Lahore.
Amjad Ali
Assistant Professor, Department of Economics, University of the Punjab, Lahore.
Email: chanamjadali@yahoo.com

Abstract
Specific amount of food and safe drinking water are basic necessities of living human-beings. The human population of the universe is touching its highest level and counted more than seven billion, it is going towards facing a great famine as predicated by Malthus (1798)[1]. The positive and preventive checks of Malthus (1798) can be observed empirically in different parts of the world (Swaminathan and Feng 1994). The study has tested the population theory of Malthus in case of Pakistan. For investigating the long run relationship among the variables of the model Johanson cointegration technique is applied. For examining the short run dynamic Error Correction Model (ECM) is applied. The results of the study of the study supported that the Malthusian theory about the population and income growth in the case of Pakistan. Furthermore, higher population growth rate increases the food insecurity not only in long run but also in short run in case of Pakistan.

Keywords: population growth, food insecurity, gross domestic product, consumer price index
JEL Codes: Q56, Q18, E01, E31

INTRODUCTION

Malthus (1798) started the debate that food scarcity as an important issue for growing population of the globe; he developed a theoretical framework between earth's carrying capacity and growing population. "The power of population is indefinitely greater than the power in the earth to produce subsistence for man" (Malthus, 1798). The empirics reveal that the availability of clean drinking water and cultivable land are going scare while population is growing at a constant pace. This alarming rise in population puts human-being in a universal famine as predicated by Malthus (1798). Now-a-days the availability of sufficient food for growing population is prime concern of developed and developing countries. Being the biggest continent Asia has lot of water and cultivated land reserves. But on the other hand, Asia also has large proportion of world population (36% of world population) with high population density and growth rate (The United Nations Population Fund, UNFPA, 2003). This rising trend in population growth reduces per capita cultivable land even more in coming years. The economies of South Asia are also facing the problem of rising population with limited cultivable land, moreover old agriculture methods of these economies causes low agriculture productivity. Pakistan and India are facing soil erosion due to deforestation, water logging due to poorly managed irrigation systems, increased soil salinity, and pollution of drinking water supplies (Kanwer, 2003).

According to the Economic Survey of Pakistan (2011-12) the estimated population of Pakistan is 182.1 million. Although Pakistan is the second most populous country in South Asia but it has highest population growth in the region. Moreover, with this population growth

[1] Malthus stated that when number of men surpasses their means of subsistence, famines epidemics and wars take place.

by 2050 Pakistan would be the fourth most populous country of the world surpassing Indonesia and Brazil (SBP, 2007). This enormous rise in population is causing serious concerns regarding the food insecurity in Pakistan, more than half of the Pakistan's population is food insecure (UNFPA, 2003).

The food insecurity in Pakistan is directly linked with low agricultural productivity. The empirics show that the share of agriculture to GDP is decreasing with every passing year (Economic Survey 2011-12). But no serious attention has been paid to the agriculture sector for obtaining food security and enhancing agriculture productivity. Pakistan is an interesting case study for examining the problem of food insecurity. In the case of Pakistan, the concept of food insecurity should be eliminated through dynamic changes in agriculture production. The low productivity of the food crops occupies a special position when we study the linkages between the rising population and food security issues. The food crops mainly include wheat, rice, sugar cane, barley, maize and other minor crops. In the year 2011, the country witnessed the worst wheat crisis of its history and same is the case with the other food crops (Economic Survey 2011-12). This study will enable the policy makers to judge the problem of food insecurity in Pakistan and find its long run solutions.

LITERATURE REVIEW

There is vast food of literature is available which discover the relationship between availability of food and population growth among high and low income countries. The food production depends on natural resources, agriculture sector performance, public investments and incentives for private farmer in rural health care supply and privately funded research and development plan and intervention produce spillovers for significantly strengthen agricultural productivity sector. In previous literature a number of studies analyze the agriculture productivity with some physical inputs such as fertilizer and pesticides. Some comprised labour inputs in their analyses, human capital to explain growth in food (Antholt, 1994; Beal, 1994; Evenson and McKinsey, 1991; Jamison and Lau, 1982; Nehru and Dhareshwar, 1994; Pardey et al., 1992; Pray and Evenson, 1991; Rosegrant and Evenson, 1992). The developing countries suffer from food insecurity due to different reasons but diets deficit is faced nearly all groups of age like infants, young children, adolescent girls and women of reproductive age (Kennedy and Meyers, 2005). But due to lack of micro level data the picture of food insecurity is still ambiguous.

Population Environment Development and Agriculture (PEDA, 2001) criticisms that per capita agricultural production by the end of the next 25 years will be less than 80 percent of what it was in 1995. Similarly, the proportion of food-insecure in the population is expected to increase over the projection period by almost 10 per cent while food imports will increase by more than 7 percent annually in order to stabilize the proportion of food insecure people in the country (Economic Report on Africa, 2001). After nearly three decades of grappling with these issues, only within the last ten years has an approach to national food security measurement achieved broad consensus. The tool of choice used by the United States Agency for International Development (USAID) to monitor national food security, inserted since 1995 into the annual Current Population Survey, is a validated set of eighteen questions about behaviour and attitudes that collectively distinguish households experiencing different degrees of food insecurity (Hamilton et al., 1997).

United States Agency for International Development (USAID, 2008) examines that that a large portion of world's population is facing the problem of food insecurity and much portion of this population is residing in rural areas. Moreover, growing urbanization and vulnerability

of low income urbanization and food production shocks may worsen the situation of food insecurity in developing countries.

Radimer et al., (1990) presented the theoretical background for availability of food and economic situation of nation. Wehler et al., (1992) measure the food insecurity in case of USA. Core Food Security is underpinned by the notion that the experience of insecurity prompts predictable responses that are quantifiable in a way that "food security" itself is not. These behaviours and attitudes relate to insufficient quantity and quality of food, food procured through personally and socially unacceptable means, and feelings of vulnerability to downturns in supply (Kendall et al., 1995; Radimer et al., 1990; Radimer et al. 1992).

A large number of studies organized on the relationship of food security and population on the bases of different economic, social, and demographic characteristics such black-white, rural-urban and families with children and without children.[2] Most of the studies focused on US economy and other industrialized countries try to explore the experiences for subpopulation and food insecurity such as (Lee et al., 2000; Wolfe et al., 2003; Dachner and Tarasuk 2002; Harrison et al. 2003; Melgar-Quinonez et al. 2006; Derrickson and Anderson 2000; Derrickson, et al, 2000; Derrickson et al. 2000; Hamelin et al, 1999; Parnell et al. 2001).

Melgar-Quinonez et al. (2006) food expenditure aggregate was generated as part of the total household expenditures calculation. Daily per capita consumption (DPC) food expenditure, which represented over 60% of the total household consumption, as well as expenditures on specific food groups correlated with food insecurity both as a continuous food insecurity regression analysis were execute change for social and demographic covariates. Food-secure households have significantly higher total food expenditures as well as expenditures on animal source foods, vegetables, and fats and oils than moderately and severely food-insecure households. It has also been observed that in the short run increase in food prices will not be fully reflected in the incomes of all related segments of the society. Income is stickier than commodity prices. Finally, it is concluded that poverty rate increases in Pakistan due to increase in food prices in the short span of time (Amjad and Thomason, 2008).

The basic objective of the present study is to analyse how rising population linked with the agricultural productivity and food security. For this purpose, data has been utilised from 1971 up to 2011. For our analysis we have applied the empirical techniques like J-J Test for cointegration and ECM for short run behaviour. This paper provides new directions for policy making authorities to lower down the trend of food insecurity in Pakistan.

THEORETICAL MODELLING, DATA AND ECONOMETRIC METHODOLOGY

Data of all selected variables has been obtained from World Development Indicators (WDI), International Financial Statistics (IFS) and various issues of Economic Survey of Pakistan. The study utilizes the data period from 1971 up to 2013. To find the required linkages, the following model has been constructed:

$$FOD = \varphi_{\circ} + \varphi_1 POP + \varphi_2 GDP + \varphi_3 CPI + \varphi_4 AGR + \varphi_5 Trend + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where;
FOD = Food availability (proxy for food security)
POP = Population growth rate

[2] .

GDP = GDP growth rate
CPI = Consumer price index
AGR= Percentage share of Agriculture in GDP
Trend = Time trend

JOHANSEN CO-INTEGRATION TECHNIQUE

Engle and Granger (1987) discussed that, if a set of economic series is not stationary at *I(0)* then there may be exist some linear combination of the variables that is stationary at *I(1)*. When all the variables are non-stationary at level but stationary at 1st difference, this leads us to apply Johansen co-integration technique. In econometric analysis, two variables are co-integrated if they have a long-run relationship between them (Johansen 1991, 1995). Pesaran and Smith, (1999) and Pesaran et al., (2000) suggested to apply co-integration test on the set of variables which contain possibly a mixture of *I(0)* and *I(1)*. The general form of the vector error correction model is as follows:

$$Z\aleph_t = \sum_{i=1}^{p-1} \theta\aleph_{t-1} + \alpha_\circ + \eta_t$$

This can also be written in standard form as:

$$\Delta\aleph_t = \sum_{i=1}^{p-1} \Pi_i \Delta\aleph_{t-k} - \partial\aleph_{t-k} + \alpha_1 + \varepsilon_t$$

Where

$$\prod_i = -I + \partial_1 + \partial_2 + ... + \partial_t$$

$$i = 1,2,3,...k-1 \text{ and } \partial = I - \partial_1 - \partial_2 - ....\partial_k$$

Where p represents total number of variables considered in the model. The matrix $\prod$ captures the long run relationship between the p-variables. Now for the Johansen Test we apply the Trace test, which is based on the evaluation of $H_\circ(r)$ against the null hypothesis of $H_\circ(r+1)$, where r indicates number of co-integrating vectors. The co-integration test provides an analytical statistical framework for investigating the long run relationship among economic variables in the model. Having established the relationship among the variables, remain weather in the short-run changes of variables we use the following specification of the model.

$$FOD = \gamma + \alpha\eta_{t-i} + \sum_{i=0}^{p} \beta_{gdp} \Delta GDP_{t-i} + \sum_{i=0}^{p} \beta_{cpi} \Delta CPI_{t-i} + \sum_{i=0}^{p} \beta_{gre} \Delta G\,\mathrm{R}\, E_{t-i} + \sum_{i=0}^{p} \beta_{trend} T_{t-i} + \nu_t$$

Where v_t the error is term and α is short run speed of adjustment,

Johansen and Juselius (1990) provide critical values for the two statistics. The statistical distribution depends on the number of non-stationary components in the model. To determine the non-stationary components, it is necessary to choose the lag length for the VAR portion of the model. To overcome this problem, this work determines the optimal lag length using Akaike's Information Criterion (AIC) and Schwartz Bayesian Criterion (SBC)[3]. The lowest values of AIC and SBC are used to select the lags and give the most desirable results.

EMPIRICAL RESULTS AND DISCUSSIONS

This study is examining the links between the food security and population growth in the case of Pakistan. The preliminary step in this analysis is concerned with establishing the degree of

[3] The distribution of the test statistic is sensitive to the order of lag used. If the lag order is used less than the true lag, then the regression estimates will be biased and the residual terms will be serially correlated. If the order of lag used exceeds the true order, the power of the test is reduced.

integration of each variable. We employed Augmented Dickey Fuller (ADF) test to check stationarity of series. The results presented in Table-1 reveal that all variables are having unit root problem at level *I(0)* but all are stationary at order *1(1).*

Table-1
Unit-Root Estimation

Variables	Level		First Difference	
	Intercept and trend	No. of lags	Intercept and trend	No. of lags
POP	-1.0453	0	-3.6734	0
GDP	-2.2687	2	-5.8973	2
LCPI	0.6935	4	-6.2588	1
LAGR	-2.9076	1	-5.5990	1
FOD	-2.3929	1	-4.4600	2

Table-2
Lag Length Selection

Lags	Akaike Information Criteria	Schwartz Bayesian Criteria	Log Likelihood
0	-1.5964	-1.3742	32.9373
1	-9.9905	-8.6574*	204.8351
2	-10.0280*	-7.5839	230.4908
Short-run Diagnostic Test-Statistics Serial Correlation LM, F = 1.98(0.159) ARCH Test: 0.273(0.605) Normality J-B Value = 0.0437(0.968) Heteroscedasticity Test, F = 0.518(0.892) Ramsey RESET Test, F = 0.948(0.339)			

After establishing that all the individual series under consideration are stationary, the Johansen Co-integration technique is used to estimate the long-run relationship among the variables, particularly population growth, GDP growth, share of agriculture, consumer price index and food security[4].

The results of Johansen Co-integration analysis are summarized in Table-3, where both maximum-eigen values and trace-test values examine the null hypothesis of no co-integration against the alternative of co-integration. Starting with the null hypothesis of no co-integration ($R = 0$) among the variables, the trace-test statistics is 92.10, which is above the 1% critical values.

[4] Optimal lag length is selected at second lag, using Akakie's information criterion (AIC) and Schwartz criterion (SIC) as shown in Table-2.

Table-3
Johansen's Multiple Co-integration Test Results

Hypotheses	Trace-Test	0.05 critical value	Inst-Value	Hypotheses	Max-Eigen Statistic	0.05 critical value	Inst-Value
R = 0	92.1054	69.8188	0.0003	R = 0	48.8102	33.8768	0.0004
R ≤ 1	43.2952	47.8561	0.1255	R = 1	20.7255	27.5843	0.2932
R ≤ 2	22.5696	29.7970	0.2678	R = 2	13.9464	21.1316	0.3694
R ≤ 3	8.6231	15.4947	0.4014	R = 3	8.4797	14.2646	0.3320
R ≤ 4	0.1434	3.8414	0.7049	R = 4	0.14341	3.8414	0.7049

Hence it rejects the null hypothesis $R = 0$ in favour of the general alternative $R = 1$. It is concluded that there is one co-integrating vector amongst the five *I(1)* variables. Therefore, analysis of annual data from 1971 up to 2013 appears to support the proposition that there exists a long-run relationship among the variables in the case of small developing economy like Pakistan.

Tabel-4
Long Run Coefficients[5]

Dependent Variable: FOD				
Variables	**Coefficient**	**Prob-values**	**Coefficient**	**Prob-values**
Constant	8.2137	0.0000	10.1327	0.0000
GDP	0.0080	0.0475	0.01238	0.0166
POP	-0.1933	0.0340	-0.2509	0.0269
CPI	0.0887	0.0883	0.2900	0.0000
AGR	0.3526	0.0539	**…..**	**…..**
TR	**…..**	**…..**	-0.2322	0.0213
Trend	0.0205	0.0000	**…..**	**…..**
R^2 = 0.981 **F-Statistic =**305.05 (0.000)			**R^2 =** 0.966 **F-Statistic =**300.01 (0.000)	
Adj-R^2= 0.978 **Durbin-Watson =**2.20			**Adj-R^2=** 0.961 **Durbin-Watson =**1.43	

The long run results of the study are presented in the table-4. The table-4 presents two types of results first Pakistan is closed economy with time trend and second Pakistan is an open economy without time trend and domestic agriculture growth. The results show that there is positive and significant relationship between economic growth and availability of food. The result show 1 percent increase in economic growth bring 0.0080 percent increase in availability of food in Pakistan. The estimated results show population growth has negative and significant impact on available food, the results show 1 percent increase in population 0.1933 percent decrease is occurred in available food in Pakistan. The results show inflation has positive and significant relationship with available food in Pakistan. The results in the table-4 reveal that there is positive and significant relationship between agricultural growth and availability of food in Pakistan. There is positive and significant relationship between time trend and available food in Pakistan over the selected time period. On the other hand when Pakistan is an open economy, the results show there is positive and significant relationship between economic growth and available food. The estimated results show population growth has negative and significant impact on availability of food in Pakistan. The results reveal that inflation and availability of food has positive and significant long run relationship. Trade openness is

[5] Empirical estimations are available on request from authors.

influencing availability of food in Pakistan negatively and significantly over the selected time period. The estimated coefficients of economic growth, population growth, inflation rate reveal stronger impact on availability of food in case of open economy as compare to closed economy. The overall long run results show population growth and trade openness are becoming the big reasons of food insecurity in Pakistan.

Table-5 **Short-Run Error Correction Model (ECM)**

Dependent variable: FOD			
Variables	**Coefficients**	**T-values**	***Prob*-values**
Constant	0.0289	1.2756	0.2130
DPOP	-0.3236	-2.1169	0.0436
DGDP	0.0056	2.0413	0.0511
$DGDP_{t-1}$	0.0054	2.7878	0.0096
DCPI	-0.0064	-0.1784	0.8597
DAGR	0.0116	2.1447	0.0411
Trend	-3.17E-05	-0.0390	0.9691
CR(-1)	-0.9640	-4.3551	0.0002
R-squared = 0.5969		Akaike info criterion =-3.268	
Adjust-R^2 = 0.4924		Schwarz criterion = -2.913	
Durbin-Watson stat = 1.860		F-statistic = 5.713 (0.00)	

The short run results are reported in table 5. The estimated results reveal that GDP and agricultural growth improve food availability position in short span of time. Time trend and food prices increase the food in-security in Pakistan in short run. The ECM coefficient explains speed of adjustment to equilibrium and it should have a statistically significant coefficient with negative sign that is another indication of cointegration among the variables (Banerjee et al., 1998). The coefficient of CR_{t-1} term is significant at 1 percent level of significance appears with negative sign, ensuring that long run equilibrium can be attained. The coefficient of *CR(-1)* is equal to (-0.964) for short run model which implies that divergence from the long-term food availability is corrected by (96.4) percent over the each year. The conducted sensitivity analysis indicates that the equations are well specified. None of the statistics shown in the Table-2 are significant at the 5 %. The model fulfilled the conditions of non-serial correlation, functional form specification and normality of disturbance term. Finally, there is evidence for existence of heteroskedesticity in short run model.

CONCLUSIONS AND POLICY IMPLICATIONS

In case of Pakistan, data shows that in spite of rising trends in both population and food there is, still mismatch between them, which accentuates food insecurity. Despite higher growth rates achieved in food production, country has not been able to develop secure mechanisms for providing access to food to a large number of poor people who are living below the poverty line in Pakistan. Country has initiated special employment and income supporting polices for improving the purchasing power of the rural and urban poor such as support prices to inputs, agricultural loans to meet the food insecurity etc. Growth in GDP and rising prices of food items reduce food insecurity despite continuous reduction in the share of Agriculture to GDP. The main reasons for slackness in the speed of decline of food insecurity are increase in input cost and rent seeking behavior of the agribusiness through hoarding. There has also been erratic public policy with respect to food items coupled with illegal trade across the border which has aggravated food insecurity in Pakistan. However, over the medium to long

run, rural farmers are likely to see improvement in their welfare as the selling price of their commodities shall rise.

For the policy recommendation, government should be able to overcome the food problem with rising population if government protects the small and medium famers through the proper functioning of the agribusiness in the economy. Excessive rent seeking, hording, lack of credit facilities and such others bottlenecks have to be properly managed by the government. In this way, production of food crop secure in future and meet the rising population demand for food with low level of poverty in the rural areas particularly. Further, smuggling of food items should be controlled in the southern and western boarder. Old varieties of seed are cropping causes the less yield in the food items. So, there is more need to focus on the research and development in the field of high yield varieties.

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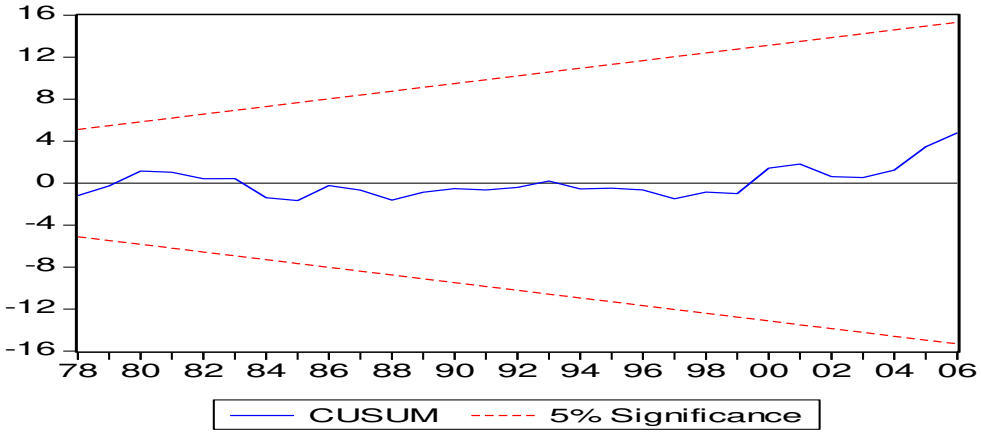
Appendix-A

Figure 1

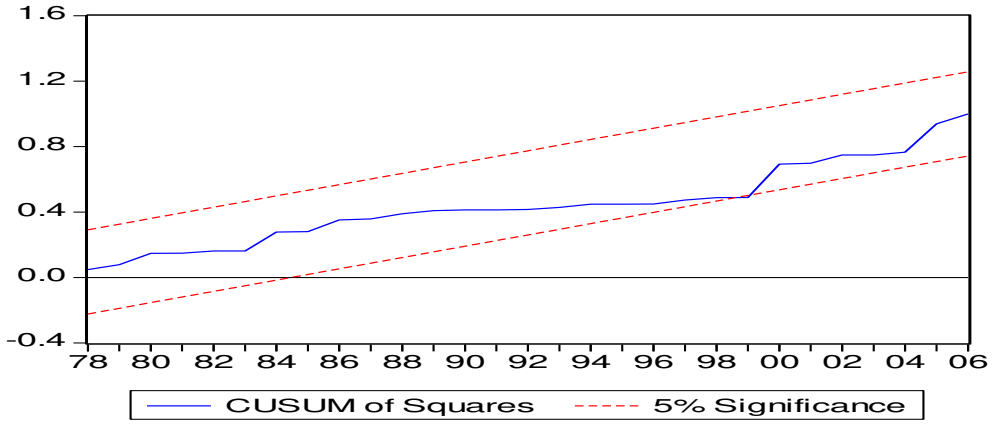
Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level.

Figure 2

Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level.