Geometric Progression in Population and Arithmetic Increase in Food Production: Evaluating Malthusian Population View in Context of Pakistan

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Abstract

The objective of the study is to evaluate Malthusian theory of population in an actually sense where the population growth is increasing geometrically while food production increases arithmetically, by considering a case study of Pakistan economy due to its high annual population percentage growth rate, which could be cumbersome for the economy in terms of food security issues. As per our knowledge, this is the first study that evaluated Malthusian view of population in its actually sense and included geometric series of population growth as explanatory factors, by taking a time series data set from 1975-2016. The results show that geometric series of population growth at 2^{nd}, 4^{th}, 16^{th}, 256^{th} and 65526^{th} confirmed the positive relationship with the food production with the coefficient elasticities of 1.054%, 0.527%, 0.263%, 0.131%, and 0.065% respectively. On the basis of decreasing percentage elasticity at different geometric series of population growth, it is quite evident that the elasticities goes down from 1 to 1 corresponding relationship to 0.065%, which validate the Malthusian theory of population, as earth's resources are limited and each and every additional increment in the population growth exhausts food production, which ultimately leads to starvation and hunger. The study conclude that Pakistan's economy should have to increase agricultural production to meet the growing needs of the country's population, as Malthusian does not advocate against the family planning, therefore, we left the unfilled space for the policy makers to filled the space by strong policies for healthy population growth and high food production in a country.

Keywords: Population growth; Food production; Malthusian view; Robust least square regression; Pakistan.

1. Introduction

For half the world population, the major economics problem is getting enough to eat. By standard of life, they are separately poor. For achieving economic growth, more output offers real hope of raising the subsistence level of living. In the world, millions of people do not continually hope for more income, in order to acquire more of the material comforts of life and mass starvation is just around corner for the larger part of the world because of rapid growth of population (Von Braun, 2007).

Population is referring to a human resource of a nation. This human resource plays dynamics role in the agriculture development of the nation. The population of the country portrays a double faced phenomenon. It is on the one hand an asset and on the other hand a vital factor in the development process of a country (Coale and Hoover, 2015).

Pakistan's population plays a dynamic role in the agriculture development of the country. In Pakistan there is abundant land which is still lying uncultivated and not takes maximum benefit. During the last fifty years, this sector has played an important role by providing food stuff to the high population growth and generates sufficient job opportunities

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to a large proportion of the population and provided the main source of national income (Economic Survey of Pakistan, various issues).

According to the Economics Survey of Pakistan, the agriculture is the life line of Pakistan's economy, accounting for 19.5percent of the gross domestic product, employing 42.3 percent of the labor force and providing raw material for the several valued industries (Economic Survey of Pakistan, 2016)

Thomas Robert Malthus discussed the view point of higher population growth and its impact on food productivity and natural resources and concluded that population growth is geometrically progress while food production moves arithmetically, therefore, it would be cumbersome in the long-run where people search for a food and there will be no food at all, hence, he suggested some positive and confirmatory check for population control and handle food security issues.

The scope of this study has vast literature investigated by many researchers explored the importance of population on agriculture productivity and economic development across countries. Schneider et al (2011) investigated the impact of population growth, economic development, and technical change on global food production and consumption. The finding of the study shows that per capita food levels increase in all development scenario with minor impact on food prices and strongly increase the prices of land and water resources. Amjad and Kemal (1997) investigated microeconomic policy and their impact on poverty alleviation in Pakistan. The findings of the study shows that economic policies perused under the structural adjustment programs have tended to increase the poverty level mainly decline in growth rate. Rahman et al (2014) investigated the impact of agricultural credit on Agricultural productivity in Pakistan, and concluded that house hold size, income of household, education of farmers, agricultural credit, and short and long term loans have significant positive on Agricultural yield per acre. The study suggested that in time provision of appropriate amount of loan may increase the agriculture productivity in a country. Brownson et al (2012) investigated the dynamic linkages between key economic indicators and agricultural productivity in case of Nigeria and found the negative relationship between real exports, inflation rate, and external debts, while there is a positive relationship between GDP per capita and agriculture productivity in a given country. Chandio et al (2016) evaluated the sectoral performance of agricultural value added on country's GDP in a context of Pakistan and found that agriculture sector significant positively impact on agricultural GDP. The study suggested that Government should make intervention in agriculture sector by introducing technologies for long-term growth in a country. Abobaw et al (2013) considered a case study of Ethiopia and confirmed the positive association between cooperative membership and fertilizer adaptation in a given country. Bilsborrow et al (1987) drew a conceptual framework for population-growth nexus and found the inverse relationship between population growth and economic happiness in terms of increasing standard of living of the common people. Buhoug and Urdad (2013) concluded that urban population pressure leads to high risk of social disorder, hence it is imperative to reduce internal migration and high population burden across countries. Hayashi et al (2013) found the significant increase in the water –stressed population increase in crop demand. Heltberg (1998) indicated the inverse relationship between farm size and farm yield, thus it is necessary to look after the appropriate farm size and reduce the population burden from it to get more yield.

Holden and Otsuka (2014) considered a case study of Africa and investigated the possible causation between land tenure reforms and land markets in a given country and found an inverse relationship between the two factors. Mojo et al (2017) concluded the positive association between farmer cooperative memberships and household income and assets in Ethiopia. Raza et al (2012) confirmed the positive relationship between agricultural value added and Pakistan's economic growth, while forest sector account negatively in

country's development due to high resource depletion. Ranis and Stewart (2000) confirmed the positive correlation between human development and economic growth in cross-country regression apparatus and thus conclude in favor of human capital development across countries. Thirtle and Lin (2003) empshzied the need of agricultural led growth that helpful to reduce poverty and hunger from African countries, Asian countries and Latin American countries. These countries are being used as sample in this study for robust inferences. Murgai et al (2012) evaluated post agrarian reforms in Pakistan's and India's rural Punjab and confirmed the positive relationship between agricultural growth rates ad agriculture inputs in both nations. Pender et al (2004) found that population pressure accountable for social inclusion and lower crops production in a given country. Kumar et al. (2008) considered a case study of South Asia and confirmed the positive association between factor productivity and agriculture growth across countries. Ali et al (2013) considered a case study of Pakistan to evaluate the impact of high mass population pressure on country's economic growth and found a direct association between the two stated factors.

On the basis of significant discussion on the stated topic, the objectives of the study is to evaluate the dynamic linkages between population growth and food production in a given context of Pakistan by using an annual time series data from 1975-2016. This study is first ever study, as per authors believe that evaluated population-growth nexus in a real sense by incorporating geometric series of population and arithmetic series of food production that is the novel contribution in the existing literature to filled it with the sound policy inferences.

2. Data and Methodology

The data has obtained from World Development Indicators published by World Bank (2017), covered a time period from 1975-2016. The time series data includes agriculture value added as a percentage of GDP that served as proxy for food production (denoted by FP) and population growth as annual percentage that served as a proxy for high population growth (denoted by PG) in terms of geometric progression. The study used geometric series of population growth as explanatory factors, including square of population growth (denoted by PG^2), power 4 of PG (denoted by PG^4), power 16 of PG (denoted by PG^{16}), power 256 of PG (denoted by PG^{256}), and power 65526 of PG (denoted by PG^{65526}).

The study used the following non linear regression equation.

$$\ln(FP) = \beta_0 + \beta_1 \ln(PG) + \beta_2 \ln(PG)^2 + \beta_3 \ln(PG)^4 + \beta_4 \ln(PG)^{16} + \beta_5 \ln(PG)^{256} + \beta_6 \ln(PG)^{65526} + \varepsilon \quad (1)$$

Where, ln shows natural logarithm, FP shows food production, PG shows population growth, and ε shows error term.

The study used robust nonlinear regression technique to explain the impact of population growth on agriculture value added in the context of Pakistan. The robust nonlinear regression is accountable to minimize possible outliers both from the regressand and regressors and used three estimators for this purpose, i.e., 'M-estimator' restricted the regressand outliers, 'S-estimator' limitize the repressor's outliers, and 'MM-estimator worked under the both regressand and regressors where it utilized to minimize outliers both from the regressand and regressors together to give robust inferences. This study used MM-estimator for possible restricted the outliers from regressand and regressors.

3. Results and Discussions

Table 1 shows the correlation estimates in view to evaluate Malthusian view of population in the context of Pakistan.

Table 1: Correlation Matrix

Correlation (Prob.)	FP	PG	PG^2	PG^4	PG^{16}	PG^{256}	PG^{65526}
FP	1						

PG	0.808	1					
	0.000	-----					
PG^2	0.803	0.998	1				
	0.000	0.000	-----				
PG^4	0.784	0.985	0.993	1			
	0.000	0.000	0.000	-----			
PG^{16}	0.732	0.937	0.955	0.981	1		
	0.000	0.000	0.000	0.000	-----		
PG^{256}	0.632	0.829	0.857	0.905	0.966	1	
	0.000	0.000	0.000	0.000	0.000	-----	
PG^{65526}	0.522	0.690	0.720	0.778	0.868	0.961	1
	0.000	0.000	0.000	0.000	0.000	0.000	-----

The results of correlation matrix shows that geometric progression of population growth have a positive correlation with the food production, which implies that higher is the population growth, higher is the food production that is quite visible in correlation coefficients, i.e., PG2 ($r = 0.808$, $p<0.000$), PG4 ($r = 0.803$, $p<0.000$), PG16 ($r = 0.784$, $p<0.000$), PG 256 ($r = 0.632$, $p<0.000$) and PG 65526 (0.522, $p<0.000$). The results supported the Julian Simon view of population growth, which argued that high population growth is a stimulus to growth in terms of demand and supply side of population view, i.e., on demand and supply side view, higher population growth involved more innovative ideas to produce more food grains due to meet the challenges of food grains, and it has a greater opportunity to find skilled labours from the highly populous countries like Einstein to give innovative ideas that comes up with technological innovations. Table 2 shows the robust non-linear regression estimates for ready reference.

Table 2: Robust Non-Linear Regression (RNLR) Estimates

Variables	**RNLR-1**	**RNLR-2**	**RNLR-3**	**RNLR-4**	**RNLR-5**	**RNLR-6**
Constant	2.844*	2.896*	2.896*	2.896*	2.896*	2.896*
Ln(PG)	0.454*	-----	-----	-----	-----	-----
$Ln(PG_{t-1})$	-----	-1.695*	-1.695*	-1.695*	-1.695*	-1.695*
$Ln(PG)^2$	-----	1.054*	-----	-----	-----	-----

$Ln(PG)^4$	-----	-----	0.527*	-----	-----	-----
$Ln(PG)^{16}$	-----	-----	-----	0.263*	-----	-----
$Ln(PG)^{256}$	-----	-----	-----	-----	0.131*	-----
$Ln(PG)^{65526}$	-----	-----	-----	-----	-----	0.065*
Statistical Tests						
R-squared	0.595	0.684	0.684	0.684	0.684	0.684
Adjusted R-squared	0.585	0.667	0.667	0.667	0.667	0.667

Note: * indicates 1% significance level.

The results show that there is a significant relationship between population growth and food production, as higher the population growth, higher is the food production that meets the growing needs of food production to the population with an estimated elasticity of 0.454%. The results show that if there is 10% increase in population growth, the food production increases by 4.54%, although the estimates shows the less elastic relationship, which confined that the impact of population on food grains is almost more than half of the food production, which confirmed the Malthusian view of population in a country. The study include geometric progression of population growth by including first lag of the population growth and confined that if the population growth rate is doubled, the relationship is around 1 to 1 between food production and population growth, while initial lag of the population growth shows a negative sign, which implies that population growth has a negative impact on food grains that visible in the next regression apparatus where food productivity largely decreases by 0.527% in PG4, 0.263% in PG16, 0.131% in PG256, and 0.065% in PG65526. The results are supported to the previous studies of Galor and Weil (2000), Sakanko and David (2018), Soby (2017), etc. Galor and Weil (2000) discussed the importance of technology and income relationship in Malthusian pre- and post regimes and argued that population and income growth increases together in pre-regime with less attributed to technology innovation, while at post regime, reduced population growth sustained income growth with high technology, thus Malthusian view of population is visible in different demographic transitions. Sakanko and David (2018) confirmed the supply and demand side population theory in the long-run, where high population growth consider as an asset to give skilled labor in to the labor force, while in the short-run, the result supported the Malthusian view of population, where high population growth moves opposite with the food production in a country. Soby (2017) argued that both the Malthusian and Ester Boserup view of population is important in adopting agricultural practices to produce more food grains for growing population, which comes up for the solution of food challenges across countries.

4. Conclusions

The relationship between high population growth and food security issues largely debated in the old literature of demography, where population growth consider as a i) burden on earth's planet, ii) as a source of real motivator to accommodate the large population by a high production of food grains, and iii) consider as an asset to produce genius like Einstein in

the labor force. To evaluate these three possible views, the study consider a case study of Pakistan by using the time series data from 1975-2016 and evaluate the possible relationship between population growth and food production in a given country context. The results show that at geometrically, higher population growth rate reduces the elasticity estimates of food production from 1% (at square of population growth) to 0.065% (at geometric population series at 65526), which confirmed that additional increment in the population growth decreases the food resources that verified the Malthusian view of population in a given country context. On the basis of results, the study suggested the following policy implications, i.e.,

i) Population growth check is imperative for conservation of natural resources.
ii) Food production required intensive agricultural reforms in order to meet the growing needs of population.
iii) The knowledge spillover gives more enlighten vision to the labor force to share their innovative ideas for reducing the food challenges.
iv) Modern agricultural inputs and mechanized farming would helpful to produce more food grains at less land.
v) Access to credit is another optimized solution to improve the farmer's standard of living via the adaptation of improved seeds, using fertilizer, pesticides spray and land cultivation techniques, which overcome the food shortages, and balanced the soil quality.

These policy implications would be helpful to balanced the population growth and improve food production by reduction the carrying capacity of land pressure that maintaining the land fertility with mechanized and sustainable instruments for long-term growth.

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