

UNSTABILITY OF FOOD PRODUCTION PER CAPITA AND POPULATION: ASIA

Vesna Jablanović¹

Abstract: The basic aims of this paper are: firstly, to set up an endogenous model of food production per capita and population; secondly, to estimate the food production per capita regression equation and population regression equation; and thirdly, to determine stability properties of food production per capita and population in Asia during the period 1967-1997.

Empirical content of this model confirms the fact that movement of food production per capita and population had unstable character in Asia in the observed period.

Key words: food production per capita, population, stability.

I n t r o d u c t i o n

Food shortages caused by natural and human-caused disasters continue to affect many countries in all regions of the world. As of early 2001, there were 33 countries and more than 60 million people facing food emergencies of varying intensity. (FAO, 2001, pg 19).

The world population of 5.9 billion of the base year (three-year average 1997/99) and 6.06 billion of 2000 will grow to 7.2 billion in 2015, 8.3 billion in 2030 and 9.3 billion in 2050. The growth rate of world population peaked in the second half of the 1960s at 2.04 percent p.a. and had fallen to 1.35 percent p.a. by the second half of the 1990s. Further deceleration will bring it down to 0.9 percent in 2015-30.

The South Asia population of 1.3 (East Asia- 1.8) billion of the base year (three-year average 1997/99) will grow to 1.7 (2.1) billion in 2015, 1.9 (2.3) billion in 2030. Deceleration of the growth rate of South Asia (East Asia) population will bring it down to 1.1 (0.5) percent in 2015-30.

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The historical evidence suggests that the growth of the productive potential of global food production has so far been more than sufficient to meet the growth of effective demand. Food production will continue to increase but its rate of increase is expected to fall from 2.2 percent a year over the last three decades to 1.5 percent a year over the period to 2030. However, it will still exceed population growth.

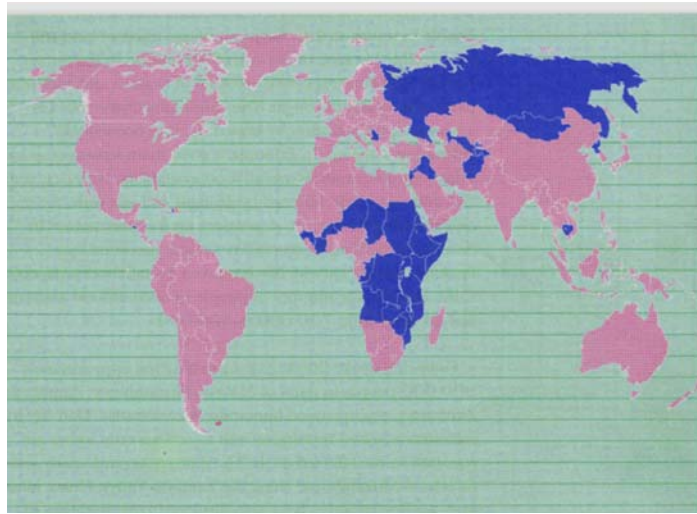


Fig. 1. - Countries experiencing food supply shortfalls and requiring exceptional assistance.
Source: FAO, 2001.

Relatively low growth in agricultural output in 2000 seem to have declined further in 2001 in Asian developing countries.

Model

The essence of the model can be simply formulated in differential form (Jablanović [3]). The rate of change of food production per capita, f' , is a proportion, β , of the food production per capita, f . On the other hand, when population, n , grows then food production per capita, f , declines, at the rate γ . Then :

$$f' = \alpha + \beta f - \gamma n \quad (1)$$

Further, it is assumed that the rate of population change, n' , is a proportion, σ , of food production per capita, f . When population, n , grows then the rate of population change, n' , increases at the rate μ .

Thus

$$n' = \lambda + \sigma f + \mu n \quad (2)$$

The characteristic equation of our system of differential equations (1)-(2) is

$$r^2 - (\beta + \mu)r + (\gamma\sigma + \mu\beta) = 0 \quad (3)$$

The complete solutions of our system (1)-(2) are the sum of the homogenous and particular solutions. Depending on the nature of roots of the characteristic equation (3) the solutions may have the following forms:

❖ *Real and distinct roots:*

$$f(t) = C_1 e^{r_1 t} + C_2 e^{r_2 t} + f^* \quad (4)$$

$$n(t) = \frac{\beta - r_1}{\gamma} C_1 e^{r_1 t} + \frac{\beta - r_2}{\gamma} C_2 e^{r_2 t} + n^* \quad (5)$$

❖ *Real and equal roots:*

$$f(t) = C_1 e^{rt} + C_2 t e^{rt} + f^* \quad (6)$$

$$n(t) = \frac{(\beta - r)C_1 + C_2 + (\beta - r)C_2 t}{\gamma} e^{rt} + n^* \quad (7)$$

where

$$r_1, r_2 = \frac{\beta + \mu}{2} \pm \frac{1}{2} \sqrt{(\beta + \mu)^2 - 4(\gamma\sigma + \mu\beta)}$$

❖ *Complex roots:*

$$f(t) = e^{ht} [A_1 \cos(vt) + A_2 \sin(vt)] + f^* \quad (8)$$

$$n(t) = e^{ht} \left[\frac{(\beta - h)A_1 + vA_2}{\gamma} \cos(vt) + \frac{(\beta - h)A_2 - vA_1}{\gamma} \sin(vt) \right] + n^* \quad (9)$$

where

$$h = (\beta + \mu)/2$$

and

$$v = \frac{1}{2} \sqrt{4(\gamma \delta + \mu \beta) - (\beta + \mu)^2}$$

where e^{ht} will grow without limit if $h > 0$. On the other hand, if $h < 0$, then e^{ht} converges to zero. As a result, $f(t)$ and/or $n(t)$ diverges in ever-increasing oscillations if $h > 0$ and converges to f^* and/or n^* in ever-decreasing oscillations if $h < 0$. Because h is often referred to as the real part of complex root, we conclude that $f(t)$ and/or $n(t)$ converges to f^* and/or n^* if the real part of the complex root is negative,

and

$$f^* = \frac{-\lambda \gamma - \alpha \mu}{\mu \beta + \sigma \gamma} \quad \text{and} \quad n^* = \frac{\sigma \alpha - \beta \lambda}{\mu \beta + \sigma \gamma} \quad (10)$$

Empirical content

In Asia, "... vulnerable population in a number of countries continue to be affected by serious food supply difficulties resulting from past disasters and the effects of economic turmoil..." (FAO, 2000, pg 9)

Our analysis confirms FAO's statement. Namely, the regression lines are:

$$\hat{f}_{At} = e^{0.042966 t} [-0.064032 \cos(-0.025078 t) - 0.210217 \sin(-0.025078 t)] + 0.622283$$

$$R = 0.99462 \quad \text{Variance explained : 98.928\%} \quad (11)$$

$$\hat{n}_{At} = e^{0.042966 t} [0.278077 \cos(-0.025078 t) + 0.015291 \sin(-0.025078 t)] + 0.282652$$

$$R = 0.99939 \quad \text{Variance explained : 99.878\%} \quad (12)$$

In this sense we obtain estimated value of parameters:

$$\gamma = 0.0207317, \quad \beta \delta = 0.0338193, \quad \mu = 0.0521127, \quad \sigma = 0.034367, \quad \alpha = -0.0151843, \quad \lambda = -0.036114$$

Our verified system (1)-(2) are:

$$\hat{f}'_A = -0.0151843 + 0.0338193 f - 0.0207317 n \quad (13)$$

$$\hat{n}_A = -0.036114 + 0.034367 f + 0.0521127 n \quad (14)$$

we can see that $h = 0.042966$ or $h > 0$. In this sense we conclude that food production per capita, f_{At} and/or population, n_{At} , in Asia diverges in ever-increasing oscillations from its steady-state value f^* ($= 0.622283$) and/or n^* ($= 0.282652$).

Conclusion

In recent years the growth rates of world agricultural production have slowed because demand for agricultural products has also slowed. This is mainly because world population growth rates have been declining. A stubbornly high share of the world's population live in developing countries and so lacks the necessary income to translate its needs into effective demand. (FAO, 2002)

The basic aims of this paper are: firstly, to set up an endogenous model of food production per capita and population; secondly, to estimate the food production per capita regression equation and population regression equation; and thirdly, to determine stability properties of food production per capita and population in Asia during the period 1967-1997.

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NESTABILNOST PROIZVODNJE HRANE PO STANOVNIKU I STANOVNIŠTVA: AZIJA

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Nestašice hrane prouzrokovane prirodnim i društvenim katastrofama utiče na mnoge zemlje u svim regionima sveta. Od početka 2001, sa nestašicom hrane različitog intenziteta suočavaju se 33 zemlje i više od 60 miliona ljudi. (FAO, 2001., str. 19 vidi Sliku 1).

Svetsko stanovništvo čini 5,9 milijardi ljudi u baznoj godini (trogodišnji prosek 1997/99) i 6,06 milijardi u 2000. godini će se povećati na 7,2 milijardi u 2015, 8,3 milijardi u 2030 i 9,3 milijardi u 2050-oj godini. Stopa rasta svetskog stanovništva je dostigla vrh u drugoj polovini 1960 tih godina od 2,04 procenta prosečno godišnje i pala je na 1,35 procenta prosečno godišnje u drugoj polovini 1990-tih godina. Dalje, stopa rasta stanovništva će iznositi 0,9 procenata u 2015-30.

Istorijski dokazi sugerišu da je stopa rasta proizvodnog potencijala globalne proizvodnje hrane još uvek dovoljna da bi odgovarala rastu efektivne tražnje. Proizvodnja hrane će nastaviti da raste ali se očekuje da će stopa rasta padati, od 2,2 procenta godišnje tokom poslednje tri decenije na 1,5 procenata godišnje tokom perioda do 2030. Međutim, ona će i dalje prevazilaziti rast stanovništva.

Relativno nizak rast poljoprivredne proizvodnje u 2000. godini se nastavlja i u 2001. godini u azijskim zemljama u razvoju.

Osnovni ciljevi ovog rada su: prvo, postaviti endogeni model proizvodnje hrane po stanovniku i stanovništva; drugo, oceniti jednačinu regresije proizvodnje hrane po stanovniku i jednačine regresije stanovništva; i treće, odrediti svojstva stabilnosti proizvodnje hrane po stanovniku i stanovništva u Aziji tokom perioda 1967-1997.

Empirijski sadržaj ovog modela potvrđuje činjenicu da je kretanje proizvodnje hrane po stanovniku i stanovništva imalo nestabilan karakter u Aziji u posmatranom periodu.

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