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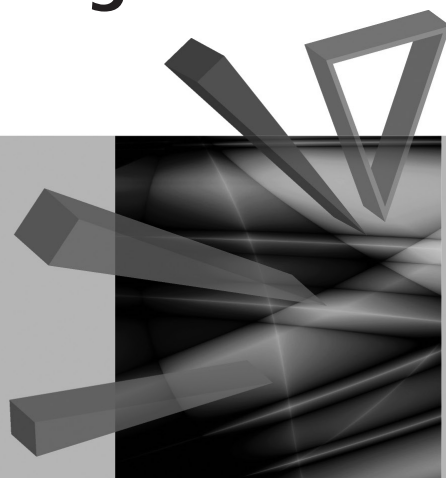
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Streszczenia

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DETERMINANTS OF THE FOOD SITUATION IN THE ASIA-PACIFIC REGION

Summary: The aim of the paper is to identify the determinants of the food situation in the Asia-Pacific region and to define the strength and direction of their impact. The data from the United Nations for Food and Agriculture Organisation (FAO) were used in the present analysis. The study, conducted with the backward stepwise regression method, showed that the share of agricultural population in general population, the agri-food trade balance *per capita* and the difference between the population growth and the agricultural production growth *per capita* have the greatest impact on the level of undernourishment in Asia-Pacific countries.

Keywords: undernourishment, Asia-Pacific region, food-situation, agricultural sector.

1. Introduction

The concept of "hunger" can be understood as a sense of hunger occurring at a time or a state, maintaining for a long time, in more or less repeated cycles, leading to the destruction of the body.[1] Today this definition is used to determine the absence of basic ingredients needed to maintain health (proteins, fats, vitamins, water). A related term is "latent hunger" (undernourishment), which is the result of prolonged low levels of food intake and/or low absorption of consumed food. Generally, it is applied to energy (or protein and energy) deficiency, but it may also relate to vitamin and mineral deficiencies.[2] Undernourishment is difficult to be noticed and its effects are difficult to be eliminated.

It should be noted that the problem of food shortages mostly affects developing countries with a high rural population density and a low level of technology in agriculture and, as a consequence, a low level of labour productivity.[3] An analysis of the problem of world hunger in relation to objectives set during the Earth Summit in 1996[4] indicates that basically only countries of the Asia-Pacific region as well as

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[1] S. Wojciechowski, Problem głodu we współczesnym świecie, *Przegląd Zachodni* 2005, nr 1.

[2] www.fao.org/hunger.

[3] J. Falkowski, J. Ostrowicki, *Geografia rolnictwa świata*, PWN, Warszawa 2001.

[4] Which are reducing by half the number of hungry people by 2015, taking as a basis the period between 1990 and 1992.

of Latin America and the Caribbean have made progress to meet this goal, but none of the regions is yet close enough to achieve it, and some of them even moved away from it.[5] Out of all of the world's undernourished population, only 1% is represented by the residents of developed countries, while one fourth live in Sub-Saharan Africa, 5% are represented by the inhabitants of South America and the Caribbean, and 4% – by the population of the Middle East and North Africa. But it is in the Asia--Pacific region that full 63% of undernourished people of the world live.[6] And even though today Asia-Pacific countries stand out as one of the key players in the global economy,[7] this alarming statistic comes from the fact that actually this region is home to half of the world's population.

The importance of the agricultural sector in creating Asia-Pacific's GDP and the importance of agricultural population in general population have declined in recent years, but it should be remembered that the issue of food security is closely linked to the agricultural situation in the region, because firstly a concentration of starving and undernourished people is observed in rural areas, and secondly – agriculture is an economic sector which produces basic food products. It seems that agriculture is the key to achieve both economic growth and food security[8] especially since it is believed that the growing demand for food will be able to be satisfied if the economic growth is faster than the population growth.[9] In this sense, the purpose of this study is to identify the factors determining the food situation in the Asia-Pacific[10] region and to define the strength and direction of the impact of these factors.

2. Sources and research methods

The study was based on the data from *Statistical Yearbook* published by United Nations for Food and Agriculture Organisation (FAO).

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[5] *The State of Food Insecurity in the World. Eradicating World Hunger – Taking Stock Ten Years after the World Food Summit*, FAO, Rome 2006.

[6] *The State of Food and Agriculture*, FAO, Rome 2011.

[7] K. Kita, The development and the importance of Asian Agricultural sector in global economy, [in:] *Research Papers of Wrocław University of Economics*, No. 125, Wrocław 2010.

[8] A. Sapa, Bezpieczeństwo żywnościowe w krajach rozwijających się, *Roczniki Ekonomiczne Kujawsko-Pomorskiej Szkoły Wyższej w Bydgoszczy* 2010, nr 3.

[9] *World Agriculture: Towards 2030/2050. Interim report*, FAO, Rome 2006.

[10] The study includes 26 major developing countries/transition economies of the Asia and Pacific region, characterised by different prevalence of undernourishment in total population. The analysis covers the years 2004–2009, which allows including the specific character of agriculture, while on the other hand – it increases the number of cases – in practice it is desirable when the number of observations *n* is much greater than the number of estimated parameters. The greater the number of observations, the greater the precision of estimated parameters (A. Stanisz, *Przystępny kurs statystyki z zastosowaniem STATISTICA PL na przykładach z medycyny. Tom 2. Modele liniowe i nieliniowe*, StatSoft, Kraków 2007, p. 59). Developed countries (Australia, Japan, New Zealand) have not been considered in the study.

Due to the complexity of the analysed problem, to study the simultaneous influence of selected variables on the prevalence of undernourishment in total population in the Asia-Pacific region, the backward stepwise regression method was used in the paper. This method implies a removal from the model built from all possible variables, the ones which in a subsequent step have the least significant impact on the dependent variable.[11] As a result of statistical[12] and logical reasons, the following set of potential predictor variables explaining a prevalence of undernourishment in total population in the Asia-Pacific region (Y) was chosen:

– X_1 – food area (hectare of arable land per person),
– X_2 – GDP *per capita* (current USD),
– X_3 – the share of agriculture in GDP (%),
– X_4 – share of agricultural population in general population (%),
– X_5 – percentage of irrigated land (arable land and pastures) in the total agricultural area (%),
– X_6 – agri-food trade balance per person (USD)
– X_7 – number of tractors per 100 km² of arable land,
– X_8 – difference between the rate of population growth and the rate of agricultural production growth *per capita* (1999–2001=100).

Unusual[13] observations (outliers) that may have a significant impact on the results of the regression analysis were removed from the data set.[14] Statistical significance of the model was verified with global *F*-test, and the significance of its parameters with *t*-test. To inspect the distribution of the residual values, which is assumed to be normal in the regression model, histograms of residual values were produced. Because of the different units of measures used in the paper, the interpretation includes regression coefficients, as well as beta coefficients, which are standardised regression parameters.[15]

3. The main factors affecting the food situation in the Asia-Pacific region

There is a considerable variation in the degree of undernourished population in the countries of the Asia-Pacific region (the share of undernourished people in the general

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[11]   A. Stanisz, *op. cit.*

[12]   Predictor (independent) variables should be correlated with the criterion (dependent) variable and should not be correlated with each other (S.M. Kot, J. Jakubowski, A. Sokołowski, *Statystyka. Podręcznik dla studiów ekonomicznych*, Diffin, Warszawa 2007, p. 328). In practice, it is required that the correlation coefficient between independent variables was smaller than the correlation coefficient between them and the dependent variable (A. Stanisz, *op. cit.*, p. 76). This principle was also used in the selection of predictor variables in the study.

[13]   Casewise deletion accounted for 7%.

[14]   T. Czekaj, Obserwacje odstające i wpływowe w analizie regresji – analiza dochodowości materialnych czynników produkcji w gospodarstwach rolnych, *Roczniki Naukowe SERiA 2006*, t. VIII, z. 5.

[15]   A. Stanisz, *op. cit.*, pp. 43–45, 101.

population ranges from 3% in Iran to 46% in Tajikistan – the variable Y, see Table 1). In every second country, 17% of its population is starving, which is a percentage similar to the average level of undernourishment observed in the analysed region of the world (17.5%).

It is worth mentioning that usually the countries where the population suffers from undernourishment are poor. In this case, an average level of GDP *per capita* accounts for just over 2000 USD (X_2). A very high variability of this index (177%) (see Table 1) may indicate a relatively large diversity of development level in Asia-Pacific countries. Furthermore, it should be remembered that with such a low level of GDP *per capita* a greater part of the household budget is spent on basic needs and, consequently, only small amount of money is spent on investment in agriculture.[16]

Table 1. Factors determining the food situation in the Asia-Pacific region in 2004–2009

Specification	Mean	Minimum	Maximum	Median	Classical coefficient of variability
Y	17.5	3.0	46.0	17.0	55.8
X_1	0.2	0.0	1.5	0.2	137.5
X_2	2089.2	92.2	21653.4	755.4	177.1
X_3	22.0	2.7	52.5	21.0	53.1
X_4	62.3	17.3	86.6	66.6	27.7
X_5	43.6	1.1	93.7	45.4	59.3
X_6	−10.1	−334.3	242.2	−9.5	x
X_7	222.7	0.1	1692.7	162.8	139.6
X_8	−1.5	−48.4	66.0	−0.9	x

x – Because of the negative values of variables in question, a calculation of the coefficient of variability does not make sense.

Source: author's own calculations based on *Statistical Yearbook*, FAO, different years.

The agricultural sector in this region is responsible for one fifth of GDP on average (X_3) and in half of the statistical population, the agricultural population constitutes 66% of the total population (X_4) (see Table 1). The smallest share of agriculture in GDP (2.7%) as well as smallest share of the rural population in total population (17.3%) was observed in South Korea, while the largest was noticed in Laos (52%) and Nepal (86.6%), respectively.

Asia-Pacific countries are characterised by a relatively small average food area *per capita* (X_1) with a high level of variability equalling 137.5% (see Table 1). It is

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[16] M. Dec, K. Pawlak, W. Poczta, Determinanty sytuacji wyżywieniowej ludności świata, *Wieś i Rolnictwo* 2008, nr 2 (139).

a consequence of both agroclimate and terrain that impedes or makes it impossible to carry out agricultural production. Thus, as a result of land resources' limitations, the food area per person is so small.[17]

Similar dispersion (above 130%) was observed in relation to the scale of mechanisation of agricultural production (X_7). In this case, it is worth noting that while for 100 km² of the arable land in Asia-Pacific on average there were nearly 223 tractors, the significant differentiation of the degree of mechanisation of agricultural production from 0.1 to 1692.7 tractors (see Table 1) is the result of a large number of mostly obsolete equipment in countries such as Tajikistan, South Korea and Pakistan.

On average 43% of agricultural land in the countries of the Asia-Pacific region is irrigated (X_5). However, a considerable differentiation of this ratio (from 1.1% in Fiji to 93% in Pakistan) is observed. Moreover, every second country irrigates less than 45% of its agricultural land (see Table 1). It should be highlighted that, as in the case of mechanisation of agriculture, irrigation requires capital outlays. These, however, due to, i.e., low level of GDP *per capita*, are not incurred and thus agriculture in this area remains inefficient and primitive. However, as far as the growth of food production is concerned, it can be noted that in half of Asia-Pacific countries it is greater than the rate of population growth (see Table 1), which indicates that agricultural production keeps up with a growing number of people (X_8). On the other hand, a considerable dispersion in the difference between the rate of agricultural production and population growth in this region (from –48.4% in Cambodia to 66% in Afghanistan) may indicate a lack of physical availability of food (see Table 1).

Among the analysed countries an agri-food trade balance per person on average amounted to –10 USD (X_6). It means that countries in the Asia-Pacific region are net importers of agri-food products (such a situation was observed in half of Asia-Pacific countries – see Table 1) and this suggests a desire to increase the food supply in this area. It can be assumed that the funds necessary to purchase food derive from the sale of agricultural but no-food products. However, the high scale of differentiation of the agri-food trade balance (i.e., –334 USD in South Korea and 242 USD in Thailand) suggests that there are countries where a large part of agri-food products is intended for exports, which in turn may lead to the lack of food self-sufficiency.

4. Factors determining the food situation in Asia-Pacific in the light of the backward stepwise regression

In order to determine the quantitative relationships between the predictor variables (X_1–X_8) and the criterion variable Y, the percentage of the undernourished population in total population of the Asia-Pacific region, the backward stepwise regression method was used. In step zero a regression equation was estimated as follows:[18]

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[17] *Ibidem.*
[18] The equation shows all the variables, both statistically significant and insignificant.

$$Y = -9.39379 - 2.25329X_1 + 0.00009X_2 - 0.000596X_3 + 0.40726X_4 + 0.01841X_5$$
$$- 0.03168X_6 - 0.00168X_7 - 0.13562X_8$$

Then, using *t*-test, statistically significant variables were determined (the solution was obtained in the 5th step of the analysis), which are presented in Table 2 as well as the value of the revised coefficient of determination[19] indicating the fit of the model.

The analysis shows that the phenomenon of undernourishment is influenced by many factors with different direction and strength of interaction. Variables X_2 (annual GDP *per capita*), X_4 (share of agricultural population in total population of the region, expressed in %), X_5 (percentage of irrigated arable land and pastures in the total agricultural area) positively influence the food situation in the Asia-Pacific region, which involves an increase of the percentage of undernourished people in the region (see the equation at the beginning of this section).

On the other hand, among the variables with a negative impact on the variable Y one can include: X_1 (food area expressed in hectares of arable land per person), X_3 (the share of agriculture in GDP), X_6 (agri-food trade balance per person expressed in USD), X_7 (number of tractors per 100 km² of arable land), X_8 (difference between the rate of population growth and the rate of agricultural production growth *per capita*), which is considered a desirable phenomenon. In fact, it means that the proportion of undernourished people in the region will decrease, among others, with increasing food area or better technical equipment of land in agriculture, expressed in the number of tractors per 100 km².

It is worth noting that predictor variable X_8, which proved to be statistically significant in the model (see Table 2), may suggest that the Asia-Pacific region does not need to be a region of relatively underdeveloped agriculture, unable to feed the growing number of people. This is proved by a negative regression coefficient (see Table 2), which indicates that in the case of growing difference between the rate of population growth and the rate of agricultural production growth *per capita* by one unit, with other factors unchanged, a percentage of undernourished population in this area can be reduced by 0.1349 percentage points.

As far as statistical significance is concerned, the agricultural population in total population (X_4) and the agri-food trade balance per person (X_6) have an important influence on the food situation in the Asia-Pacific region (see Table 2).

While the increase of agricultural population by 1% can lead to deterioration of the food problem by 0.43 percentage points, with other factors unchanged, the increase of value of agri-food trade balance for a person by 1 USD would help to improve the food security by 0.04 percentage points.

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[19] In the case of multiple regression a revised coefficient of determination (revised by degrees of freedom) should be used because the classical coefficient of determination increases with the increase of the number of variables in the model (A. Aczel, *Statystyka w zarządzaniu*, PWN, Warszawa 2000, p. 529).

The estimated model proved to be statistically significant (F (3.159) = 99.079, $p < 0.0000$) and all independent variables explained the variation of the degree of undernourishment in Asia-Pacific in 65%.

In addition, the standardised Beta coefficients (see Table 2) indicate that among the statistically significant independent variables, the predictor variable X_4 (the share of agricultural population in total population) was associated the most with the variable Y.

Table 2. Statistically significant determinants of the food situation in the Asia-Pacific region

Independent variable	BETA	Variable parameter	Standard error of the parameter	Statistic T	p-value
(X_4)	0.9177	0.4264	0.0259	16.4541	0.000000
(X_6)	−0.2718	−0.0354	0.0073	−4.8580	0.000003
(X_8)	−0.2340	−0.1349	0.0278	−4.8463	0.000003
R^2		0.8072	standard error of the regression		4.8430
revised R^2		0.6449	statistic F		90.079
Variables are statistically significant with p-value = 0.05					

Source: author's own calculations based on *Statistical Yearbook*, FAO, different years.

5. Concluding remarks

The analysis confirmed the following observations:

a) There are many factors determining the prevalence of undernourishment in the total population of the Asia-Pacific region. However, their impact on the studied problem cannot be clearly interpreted. In addition, there are unmeasurable or hardly quantifiable determinants of the level of food security (natural disasters, conflicts, flawed agricultural policy), which are not included in the analysis and which may impede the assessment of the impact of individual factors.

b) The food situation in the Asia-Pacific region is associated not only with the state of agriculture (in the region where on average 17% of the population is starving, the agriculture accounts on average for 20% of GDP and in every second country agricultural population constitutes 66% of the total population), but also with the level of socio-economic development (these countries are usually the poorest ones).

c) The share of agricultural population in general population (%), agri-food trade balance *per capita* (USD), difference between the rate of population growth and the rate of agricultural production growth *per capita* play indisputably an important role in shaping the food situation.

d) The food situation would be exacerbated with the increase of the agricultural population, while it would be improved with the appreciation of the agri-food trade balance *per capita* and with the difference between the rate of population growth and the rate of agricultural production growth *per capita*.

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www.fao.org/hunger.

CZYNNIKI DETERMINUJĄCE SYTUACJĘ WYŻYWIENIOWĄ W REGIONIE AZJI I PACYFIKU

Streszczenie: Celem opracowania jest identyfikacja czynników determinujących sytuację wyżywieniową w regionie Azji i Pacyfiku oraz określenie siły i kierunku ich oddziaływania. W analizie wykorzystano dane Organizacji Narodów Zjednoczonych ds. Wyżywienia i Rolnictwa (FAO). Badania, przeprowadzone przy zastosowaniu metody regresji krokowej wstecznej, wykazały, że największy wpływ na poziom niedożywienia mają: udział ludności rolniczej w ogóle ludności, saldo handlu rolnego przypadające na jednego mieszkańca oraz różnica między tempem wzrostu liczby ludności a tempem wzrostu produkcji rolniczej na osobę.

Słowa kluczowe: niedożywienie, region Azji i Pacyfiku, sytuacja wyżywieniowa, sektor rolny.