TECHNIUM
SOCIAL SCIENCES JOURNAL

Vol. 26, 2021

A new decade for social changes

www.techniumscience.com

ISSN 2668-7798

Technium Social Sciences Journal
Vol. 26, 455-465, December, 2021
ISSN: 2668-7798
www.techniumscience.com

Malnutrition and Economic growth, Dynamic panel data analysis of developing countries

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Abstract. This paper concentrates on the empirical analysis of the pace of change in the food security situation in developing countries. We used dynamic panel data modeling by the GMM technique of Blundel and Bond (1998) during the period which range from 1990-2018 in order to estimate the relationship between the growth rate of GDP per capita and the growth rate of under nutrition prevalence in 26 developing countries belonging to the three different regions, namely Latin America, Sub-Saharan Africa and Asia. Food security was used at a national level as measured by the prevalence of under nutrition and the magnitude of the food deficit. The results of the estimates clearly show a negative relationship between economic growth rate and under nutrition prevalence; however, the economic growth of developing countries seems to be a key factor in reducing poverty and the proportion of the undernourished population.

Keywords. Malnutrition, food security, Alimental deficit, Economic growth

1. Introduction

Food safety can be defined as the capacity of all people to a sufficient, healthily and nutritive food, the physical and the economic access. In this paper, we empirically investigate if the acceleration of economic growth leads to the reduction of malnutrition in developing countries or not, using dynamic panel data. Our study focuses on food security at the national level, generally measured by the prevalence of malnutrition; Our study will use dynamic panel data modeling, for the period 1990-2018, in order to estimate the relationship between the growth rate of GDP per head and the growth rate of the prevalence of sub-population for 26 developing countries. Firstly, we will present the literature review and the structure of under nutrition prevalence and its broad definition. In a second part, we will present our empirical methodologies as well as the definitions of the different variables. The estimation will be performed by the GMM technique proposed by Blundel and Bond (1998), the sample is composed of three regions: Latin America, Sub-Saharan Africa, and Asia. In a third part, we will present the results of estimation and a descriptive, graphical analysis related to prevalence of under nutrition and its determinants.

2. Literature review

There is a debate in the literature about the importance of economic growth in addressing the problem of malnutrition. Some authors have shown that economic growth is an

Technium Social Sciences Journal
Vol. 26, 455-465, December, 2021
ISSN: 2668-7798
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essential condition for improving nutrition in developing countries (Ravallion, 1990; Pritchett and Summer, 1996; Smith and Hadad, 2002). Other authors argue that economic growth is necessary but not sufficient to reduce under nutrition. There is a need for cost-effective investments in public health, sanitation, and a good education system (Wolf and Behrman, 1983; Timmer, 2000; Alderman et al., 2003; Suri et al., 2011; Ruel and Alderman, 2013).

The most commonly used indicator is related to under nutrition domain (Dijk and Meijerink, 2014). As consequence , This study focuses on food security at the national level, generally measured by the prevalence of malnutrition, which is defined as the population below the minimum level of food energy consumption (also referred to the prevalence of under nutrition) indicates the percentage of the population whose food intake is insufficient to meet food energy needs on an ongoing basis (Source: World Bank).Also, The prevalence of malnutrition expresses the probability that a randomly selected person in the population will consume an amount of calories that is insufficient to meet their need for the energy desired for a healthy and active life. The indicator is calculated by comparing a probability distribution of usual daily consumption of food energy with a threshold called the minimum food energy requirement.

The magnitude of the food deficit indicates how many calories would be needed to be not "undernourished". The average intensity of food deprivation of undernourished people, assessed as the difference between the average food energy requirement and the average food energy consumption of the undernourished population multiplied by the number of undernourished people to provide, which is then normalized by the total population.

3. Analysis of food security developments

We consider models that include a linear trend and quadratic[1]trend specific to each country.

The quadratic trend model is written as follows:

$$PREVAL_t = \alpha_0 + \alpha TREND_t + \beta TREND_t^2 + \varepsilon_t \quad (1)$$

With:

$TREND^2$:Quadratic linear trend.

The coefficient for the quadratic term (β),gives information about the shape of the curve. The coefficient (α) indicates the direction of the curve. If (α) is positive then we can conclude that malnutrition increases over time.

Table (1.1) shows the results of estimation of equation (1) .The adjustment coefficient for the quadratic term is statistically significant for most countries. This result indicates that the evolution of the undernourished population exhibits a quadratic trend.

Hence, our sample will be divided into four groups. :

Group 1:countrieswhich undernourishment is improving at a decreasing rate.

$\alpha \prec 0, \beta \succ 0$

Group 2: characterized countries which undernourishment is improving at an increasing rate.

$\alpha \prec 0, \beta \prec 0$

Group3:characterized countries which undernourishment deteriorated at a decreasing rate.

$\alpha \succ 0, \beta \prec 0$

[1]In general, a **quadratic form** is a homogeneous polynomial of degree two with any number of variables.

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Vol. 26, 455-465, December, 2021
ISSN: 2668-7798
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Group 4:characterized countries which undernourishment deteriorated at an increasing rate. ($\alpha \succ 0, \beta \succ 0$)

According to the results of estimations the following three groups are apparent:
Group 1: Algeria, Botswana, Costa Rica, Ecuador, Iran and Zambia
Group 2: Bolivia, Cameroon, Jordan, Morocco, Pakistan, Peru, Philippines and Zimbabwe
Group3: Bangladesh, Brazil, Chile, China, Colombia, El Salvador, Fiji, Ghana, India, Indonesia, Mexico and Paraguay

Table 1: estimations results of eq.1

	Table 1.1: estimation equation (1)		
Countries	R_sq	Alpha	beta
1-Algeria	0.76	-0,008***	34.39**
2-Bengladesh	0.77	0.006***	-24.61***
3-Bolivia	0.84	-0.022**	-91.25**
4-Botswana	0.25	-0.01***	40.94**
5-Brazil	0.55	0.008***	-35.31***
6-Cameron	0.72	-0.05***	-204.5***
7-Chile	0.8	0.01**	-44.48**
8-China	0.94	0.013**	-54.9***
9-Colombia	0.78	0.019***	-76.7
10-Costa Rica	0.04	-0.0006***	0.27
11-Ecuador	0.62	-0.01***	39.97
12-El Salvador	0.69	0.027***	-112.16
13-Fiji	0.77	0.004***	-16.47
14-Ghana	0.96	0.068***	-276.95
15-India	0.68	0.001***	-6.51
16-Indonesia	0.67	0.029***	-117.4
17-Iran	0.56	-0.007***	31.86
18-Jordan	0.47	-0.007***	-3.28
19-Mexico	0.88	0.0058***	-23.32
20-Morroco	0.74	-0.00006*	-0.145**
21-	0	-	-13.82*

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Vol. 26, 455-465, December, 2021
ISSN: 2668-7798
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Pakistan	.22	0.0034**	
22-Paraguay	0.97	0.024***	-100***
23-Perou	0.96***	-0.0005**	1.22
24-Philippines	0.97**	-0.008**	-35.94
25-Zambia	0.88***	-0.05**	240.02
26-Zimbabwe	0.93**	-0.02*	-80.96

,** et *** indicate 1,5 and 10 percent levels of significance , respectively.

4. Food security and economic growth

Along these lines, we proceed in a dynamic panel data model. Indeed, this model is more powerful than static since it allows to eliminate the specific individual heterogeneity term (η_i) and offers, therefore, a better efficiency of the estimators. The method used is the GMM system of Blundell and Bond (1998). The command used is **Xtabond2**, under the STATA software 16.0. We will, first, estimate two model for the whole sample (26 countries).Indeed, the basic equation can be described as follows:

$$PREV_{i,t} = \alpha PRE_{i,t-1} + \beta_1 GROWTH_{i,t} + \beta_2 HEALTH_{i,t} + \beta_3 ITER_{i,t} + \beta_4 IMPROWAT_{i,t} + \beta_5 DUMMY + \eta_i + \varepsilon_{i,t} \quad (2)$$

$$DEF_{i,t} = \lambda DEF_{i,t-1} + \beta_1 GROWTH_{i,t} + \beta_2 HEALTH_{i,t} + \beta_3 ITER_{i,t} + \beta_4 IMROWATER_{i,t} + \beta_5 DUMMY + \eta_i + \varepsilon_{i,t} \quad (3)$$

i: index of individuals (countries)
T: the time dimension.

-The dependent variables (food security variables):

$PREV$:The population below minimum level of dietary energy consumption (also referred to the prevalence of undernourishment) shows the percentage of the population whose food intake is insufficient to meet dietary energy requirements continuously.

DEF : The extent of the food gap is the amount of calories that lack an undernourished population to no longer be considered as such, all things being otherwise equal. The average intensity of food deprivation of undernourished people, which corresponds to the difference between the average dietary energy requirements and the average dietary energy intake of undernourished population is multiplied by the number of undernourished people to get estimate of the total existing food deficit in the country, a figure which is then adjusted to the total population. (Source :http://www.fao.org/docrep/019/as212f/as212f.pdf)

-The explanatory variables:

$GROWTH$: It is the GDP per capita, it is a proxy for economic growth.

$HEALTH$: Share of health expenditure in GDP. Total health expenditure is the sum of public and private health expenditures. It covers the provision of health services (preventive and curative), family planning activities, activities related to nutrition and using emergency reserved to health but excludes the provision of water and hygiene services.

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ITER :Adult literacy rate (15 years +) (%). It is the percentage of the population aged 15 and over who can understand, read and write short statements about her daily life. Generally, literacy also includes numeracy, that is to say the ability to perform simple arithmetic operations. This indicator is calculated by dividing the number of literates aged 15 and over by the population of the relevant age group and multiplying the result by 100.

IMPROWATER :Access to improved water source is the percentage of the population with reasonable access to an adequate amount of water coming from an improved source such as a household outlet of water, public standpipe, a well, a spring or a protected well or collected rainwater. Unimproved sources include vendors, tanker trucks and unprotected wells and springs. Reasonable access is defined as the availability of at least 20 liters per person from a source located within one kilometer of the dwelling.

DUMMY : These are binary variables relating to the regions (Asia, sub-Saharan Africa and Latin America)

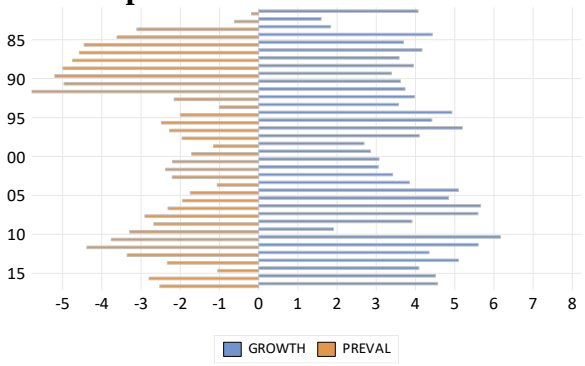
η_i : Fixed individual heterogeneity; with $\eta_i \rightarrow i.i.d.(0,\sigma_\eta^2)$

$\varepsilon_{i,t}$:An error term; with $\varepsilon_{it} \rightarrow i.i.d.(0,\sigma_\varepsilon^2)$;

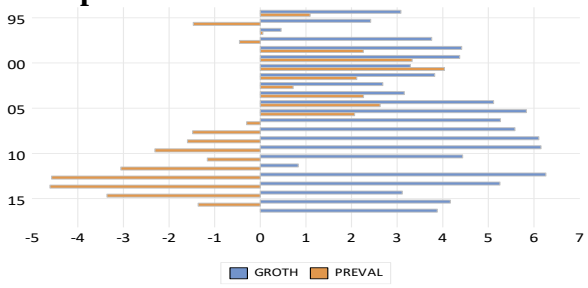
4.1 Graphical Analysis

Comparative evolution between food security and economic growth

Full sample



Group 1



Group 2

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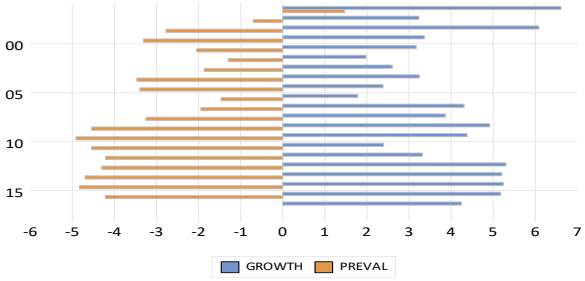
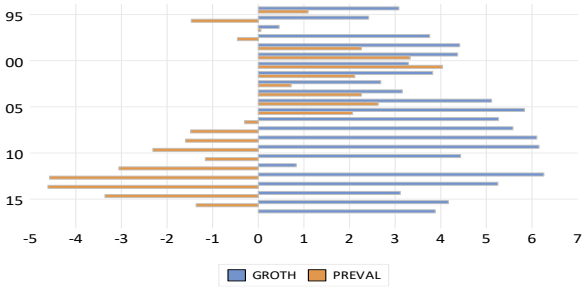


Group 3



Source: own elaboration based on the outputs of Eviews 11 software

The analysis of the comparative evolution of the economic growth rate and the prevalence of undernourishment highlights the following remarks:

-The undernourishment prevalence rate seems to go in the opposite direction with the economic growth rate of the total sample, and that's for the entire period.

- For the Group 1, it appears that the rate of economic growth has failed to compromise undernourishment during the period 2006-2003. For the group 2, during the period from 1992 to 1994, the rate of economic growth seems to be going in the same direction with the non-fed population rates.

-In regards with the group 3, the malnutrition prevalence rate seems countercyclical.

4.2. Results of estimates and interpretations

Table 2. Estimation Results of dynamic models by GMM system method (full sample)

	Dependent variable			
	DEF		PREV	
	coef	t-stat	coef	t-stat
DEF (t-1)	0.85***	88.41		
PREV(t-1)			0.35***	55.24
GROWTH	-0.72***	-4.12	-0.062***	-3.65
HEALTH	-5.00***	-3.85	-0.31**	-2.43
ITER	0.87***	6.04	0.136***	7.37
IMPROWATER	-0.264*	-1.83	-0.102***	-5.51
DUMMY_ASIE	-2.30***	37.47	-29.43***	-6.36
DUMMY_AFRICA	-2.29***	33.27	-	-7.61

Technium Social Sciences Journal
Vol. 26, 455-465, December, 2021
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			31.69***	
DUMMY_AMERIQUE	-2.04***	32.9	-28.61***	-7.11
Constant	181.3***	5.53	27.07***	6.32
M2	-1.09(0.27)		1.10(0.236)	
Sargan test	3.87(0.203)		2.06(0.231)	

*, **, and *** refer to 10%, 5%, and 1% significance levels, respectively. For Sargan test, the null hypothesis is that the instruments used are not correlated with the residuals. For the M2 test for autocorrelation, the null hypothesis is that the errors in the first-difference regression exhibit no second-order serial correlation (p-value is reported in parentheses) .

Table 3. Estimation Results of dynamic models by GMM system method (group 1)

	Dependent variable			
	DEF		PREV	
	coef	t-stat	coef	t-stat
DEF (t-1)	0.983***	7.07		
PREV(t-1)			0.72***	11.07
GROWTH	0.188*	1.64	-6.42***	-11.53
HEALTH	2.19***	7.17	-13.58***	-7.91
ITER	-0.47***	-7.80	5.70***	9.62
IMPROWATER	-0.404***	-8.48	-6.83***	-13.40
Constant	62.83***	12.05	314.2***	14.26
M2	1.12(0.63)		0.12(0.906)	
Sargan test	1389(0.17)		0.89(0.96)	

*, **, and *** refer to 10%, 5%, and 1% significance levels, respectively. For Sargan test, the null hypothesis is that the instruments used are not correlated with the residuals. For the M2 test for autocorrelation, the null hypothesis is that the errors in the first-difference regression exhibit no second-order serial correlation (p-value is reported in parentheses) .

Table 4. Estimation Results of dynamic models by GMM system method (group 2)

	Dependent variable			
	DEF		PREV	
	coef	t-stat	coef	t-stat
DEF (t-1)	0.97***	57.93		
PREV(t-1)			0.48***	6.85
GROWTH	-0.74**	-2.27	-0.57***	-3.89
HEALTH	0.49	0.58	0.94***	4.27
ITER	-0.19***	-3.31	-0.065***	-3.47

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IMPROWATER	0.294***	3.77	0.225***	5.25
Constant	-12.24	-1.43	-18.40***	-5.14
M2	0.12(0.926)		0.68(0.49)	
Sargan test	6.97(0.11)		0.62(0.88)	

*, **, and *** refer to 10%, 5%, and 1% significance levels, respectively.ForSargan test, the null hypothesis is that the instruments used are not correlated with the residuals. For the M2 test for autocorrelation, the null hypothesis is that the errors in the first-difference regression exhibit no second-order serial correlation (p-value is reported in parentheses) .

Table 5. Estimation Results of dynamic models by GMM system method (group 3)

	Dependent variable			
	DEF		PREV	
	coef	t-stat	coef	t-stat
DEF (t-1)	0.98***	60.82		
PREV(t-1)			0.48***	6.85
GROWTH	-0.44***	-4.24	-0.57***	-3.89
HEALTH	1.23***	4.36	0.948***	4.27
ITER	0.103**	2.24	-0.065***	-3.47
IMPROWATER	0.17	1.24	0.225***	5.25
Constant	-35.24***	-3.04	-18.40***	-5.14
M2	-0.38(0.70)		0.68(0.49	
Sargan test	0.93(0.91)		0.62(0.88)	

*, **, and *** refer to 10%, 5%, and 1% significance levels, respectively. For Sargan test, the null hypothesis is that the instruments used are not correlated with the residuals. For the M2 test for autocorrelation, the null hypothesis is that the errors in the first-difference regression exhibit no second-order serial correlation (p-value is reported in parentheses) .

The result of (eq.1) and (eq.2) for the group are reported in Table 2-4.

The first observation concerns the general model specification. Indeed, the specification is not rejected by the test of over-identification of Sargan. We accept, there by the validity of the instruments used. Similarly, there we accept the null hypothesis of absence of serial correlation of orders 2 of the residuals.

As expected, the rate of economic growth, access to water, health care spending and the literacy rate exhibit negative and statistically significant impact on the prevalence rates of undernourishment and food shortages. Improved growth, access to water and literacy rates lead to reductions in the rate of non-fed population. This result is consistent with results obtained by Smith and Haddad, 2000; Smith and Haddad, 2002; Alderman et al., 2003; Arcand and Béatrice, 2004; Suri et al., 2011).

Health care spending is a factor that improves food security in the entire sample. Good quality nutrition reduces the likelihood of the emergence of serious diseases caused by poor diet. Food security requires a combination of adequate dietary intake and a healthy

environment. This is true for all three groups, since this variable and negatively impacts significantly under-nutrition and / or food shortages.

The literacy rate has a negative and statistically significant impact on undernourishment. A better education system is suitable for food security. Better education facilitates better knowledge in food production and resource management. In the same vein, the authors showed that equity between men and women has a positive impact on the use and food security.(Quisumbing et al., 1995; Smith and Haddad, 2000.Hyder et al, 2005) .The Group 3 appears to have a better education system which has led to greater food security. However, this variable turns out not statistically significant in group 1.

The access to improved water, exhibited a statistically significant and negative impact. Poor sanitation device is associated with the emergence of diarrheal diseases and several other diseases (Cairncross et al, 2010;. Wolf et al, 2014). These types of diseases lead to poor absorption of nutrients (Humphrey, 2009) and contribute to global infant mortality (Liu et al., 2012). Group 2 seems to have the highest impact of this variable on food security.

The results show that a better growth rate contributes to the increase in the proportion of the population nourished. Indeed, the coefficient assigned to the variable related to the growth rate is negative and statistically significant, and this for the total sample and for all groups. Certainly the impact of the growth rate was higher in group 3. This indicates that the impact of growth is faster on food security of the remaining groups. This result is consistent with the earlier analysis that showed that this group is characterized by undernourishment deteriorating at a decreasing rate.

Concerning the variables related to regional *dummies,* it positively affects undernourishment and in a statistically significant manner. Sub-saharian Africa seems to have the worst food security, known that it displays the highest coefficient.

5. Conclusion

This paper was dedicated to the empirical study of economic growth-malnutrition, food security relationship for a panel of 26 developing countries to study if the acceleration of economic growth leads to the reduction of malnutrition in developing countries or not. The technique used is the GMM of Arellano and Bond (1991), during the period which range from 1990-2018 in order to estimate the relationship between the growth rate of GDP per capita and the growth rate of under nutrition prevalence in 26 developing countries belonging to the three different regions, namely Latin America, Sub-Saharan Africa and Asia. The estimation results clearly show a negative relationship between economic growth rates and the prevalence of undernourishment. Economic growth in developing countries seems to be a key factor to reducing poverty and the proportion of the under nourished population but not sufficient. In addition, the results show that a better growth rate contributes to the increase in the proportion of the population nourished. Also, access to water, health care spending and education are a very important factors to reduce malnutrition alongside economic growth.

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Annex
Lists of selected countries

1	***Algeria***
2	*Bostwana*
3	*Costarica*
4	*Ecuador*
5	*Iran*
6	*Zambia*
7	*Bolivia*
8	*Cameron*
9	*Jordan*
10	*Morroco*
11	*Pakistan*
12	*Perou*
13	*Philippine*
14	*Zimbabwe*
15	*Bangladesh*
16	*Brazil*
17	*Chile*

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ISSN: 2668-7798
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18	*China*
19	*Salvador*
20	*Colombie*
21	*Fiji*
22	*Ghana*
23	*Mexico*
24	*Paraguay*
25	*India*
26	*Indonesia*

List of Groups

Group 1: Algeria, Botswana, Costa Rica, Ecuador, Iran, Zambia
Group 2: Bolivia Cameroon Jordan Morocco Pakistan Peru Philippine Zimbabwe

Group 3: Bangladesh, Brazil, Chile, China, Colombia, El Salvador, Fiji, Ghana, India; Indonesia, Mexico, Paraguay
Group 4: No Country