Impact of domestic food prices on access to food in developing areas in the world

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Abstract Food security is a condition related to the supply of food and individuals' access to it. Food access and availability highly depend on price of food products. Therefore, this research looks at the impact of food price and other impediments over past years on access to food. We use a panel data set from 71 countries covering the period from the year 2000-2011. We employ a Generalized Least Squares procedure to overcome problems of heteroskedasticity and autocorrelation commonly observed in panel data. There is a clear case of the detrimental effect of domestic food prices and its volatility on access to food and thereby on food security. Findings also show that food loss at retail level critically determines depth of food deficit, more than that of the impact from national income.

Keywords: *access to food; domestic food price; depth of food deficit; Generalized Least Squares, panel data*

Introduction

In the industrialized countries, hungry people lack 130 kilocalories per day on the average, while in five of the poorest countries; the daily food deficit is more than three times of that, 450 kilocalories. Most of the countries with the most extreme depth of hunger (more than 300 kilocalories per person per day) are located in Africa. Others are in the Near East (Afghanistan), the Caribbean (Haiti), and Asia (Bangladesh, Democratic People's Republic of Korea and Mongolia). Close to 792 million people in 98 developing nations are not getting enough food to lead normal, healthy and active lives. Even in industrialized nations, the number of undernourished remains the same (FAO, 2000). Although, there has been a global drop of more than 100 million in the number of undernourished people in the past decade, food security is still a major international concern. Food prices have been volatile over the last few

decades (Hossain, 2017). After peaking in 1974, the real international food prices declined steadily until 1990 and then stagnated at a comparatively low level until mid-2007. However, between June 2007 and June 2008 international food prices rose sharply, while the decline observed between mid-2008 and mid-2010 did not offset its prior increase (Cornia *et al.*, 2012). Factors that lead to increases in food prices in the world markets include increased global demand for biofuels, feedstock and adverse weather conditions in 2006 and 2007 in some major grain- and oilseed-producing areas (Trostle, 2008). Rising food prices are a major detrimental factor in increasing access to food, which is one important aspect of food security. Although, global food production has kept ahead of demand for many years, about one billion people currently do not have such access (Ingram, 2011). Therefore, this research looks at the nature and magnitude of food prices and other impediments impacts food accessibility in major developing areas in the world.

Material and methods

Variable selection

The issue of interest discussed here is the access to food, commonly measured by indicators such as prevalence of undernourishment, share of food expenditure of the poor, and the depth of food deficit. We use the depth of food deficit to mimic access to food mainly because of data availability in most countries over the study period. The depth of the food deficit indicates how many calories needed to lift the undernourished from their status, everything else being constant. To estimate the impact of food prices on access to food, we use two indicators: The Domestic Food Price Index and its volatility. These indices are those reported by the Food and Agricultural Organization. Additionally, we include control variables such as Per Capita Food Supply Variability (measured in Kcal) the Gross Domestic Product per Capita ($), Incidence of Caloric loss at retail distribution level (%), and the Value of Food Imports over Total Merchandise Exports (%). All data in this study were obtained from the database available in the Food Security Indicators of "Food and Agriculture Organization" (FAO) covering the period of 2000 to 2011 for 71 countries from South, Central, Eastern, South Eastern, and Western Asian, African, and South American regions. We use data from these developing areas in the world because the vast majority of hungry people live in developing regions (Capone *et al.*, 2013).

The econometric model and estimation

The data set used in this study constitutes of an unbalanced panel data on 71 countries collected over multiple periods. Common issues in such panel data sets are

autocorrelation within panels and cross-sectional correlation and hetero skedasticity across panels. To overcome these issues, we employ a Generalized Least Squares (GLS) technique available in STATA software. The econometric specification of the model estimated is as below

$$DFD_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 ICL_{it} + \beta_3 DFPV_{it} + \beta_4 FSV_{it} + \beta_5 FIOE_{it} + \beta_6 DFPI_{it} + D_1 + \mathcal{C}_i \qquad (1)$$

Where:

DFD_{it}	= Depth of the Food Deficit
GDP_{it}	= Gross Domestic Product per Capita
ICL_{it}	= Incidence of Caloric Loss at Retail Distribution Level
$DFPV_{it}$	= Domestic food Price Volatility
FSV_{it}	= Per Capita Food Supply Variability
$FIOE_{it}$	= Value of Food Imports over Total Merchandise Exports
$DFPI_{it}$	= Domestic Food Price Index
D_1	= South Asian Countries (Dummy Variable)
i	= Country
t	= Time (Year)

Food accessibility is realized when every man, woman and child, alone or in community with others, has physical and economic access to adequate food at all times or means for its procurement (Ray and Schaffer, 2013). We have used Depth of Food Deficit (DFD) in kcal/caput/day as the measure of food access as it indicates how many calories needed to lift the undernourished from their status, keeping everything else constant. The difference between the average dietary energy requirement and the average dietary energy consumption of the undernourished population multiplied by the number of undernourished to provide an estimate of the total food deficit in the country, which is normalized by the total population.

The Per Capita Gross Domestic Product ($) in purchasing power equivalent calculated by sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies that are not included in the value of the products. Incidence of Caloric Loss-ICL (percent) indicates the total amount of calories lost every year. The Domestic Food Price Volatility Index measures the variability (Index) in the relative price of food in a country. It is calculated from the monthly Domestic Food Price Level Index using monthly consumer and general food price indices and purchasing power parity data from the International Comparison Program conducted by the World Bank. Food Supply Variability (kcal/ person/day) is the standard deviation over 5 years of the deviation from the trend of per capita food supply observed during the period 1999 to 2010. Value of Food Imports in Total Merchandise Exports (percent) is obtained by simple sum of the value of food imports

and total merchandise exports by regions and sub-regions and then the sum of food imports divided by sum of total merchandise exports and multiplied by hundred. The Domestic Food Price Index is an indicator of the relative price of food in a country and calculated from the 2005 World Bank data.

Results and discussion

Descriptive statistics

Figure 1 compares the DFD in least developed, developing and developed countries in the world and it has high values for least developed (Region 1) countries and low values for developed countries (Region 3). It means, least developed countries need high amount of calories to lift the undernourished from their status than other developing and developed countries. Overall, Depth of the Food Deficit decreases over period from 1992 to 2014 for all regions.
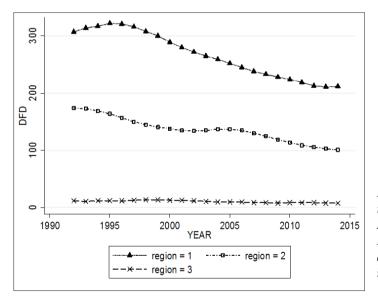

Figure 1 - DFD over the time. In here, region 1, 2 and 3 represent Least Developed, Developing and Developed countries respectively.

The spatial variation of depth of food deficit over the study period is depicted in Figure 2. It reports variation of DFD in the seven regions under study. All regions' DFD levels decreased over time except in the Western Asia, where, DFD values are slightly increasing. The South East Asian region shows a remarkable decline in DFD from being the highest DFD region in 1990's to one of the lowest in the last years of the study period.
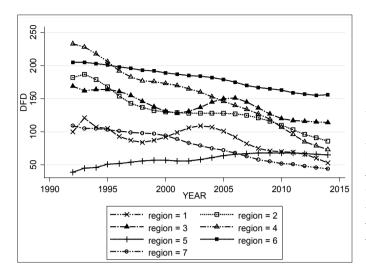
Figure 2 - DFD over the time.
In here, region 1, 2, 3, 4, 5, 6 and 7 represent Central Asian, Eastern Asian, South Asian, and Southern Eastern Asian, Western Asian, African and South American countries respectively.

Domestic Food Price Volatility (DFPV) has continuous spike and fluctuation for all regions over this selected period. Specially, South Asian region, which contain Sri Lanka, India, Pakistan etc. (Region 3), has high price hike increasing to a value of 39.6 in 2007. Other than that, Central Asian region, which include Armenia, Azerbaijan, Georgia etc. (Region 1), has high value when compared with other regions (Figure 3).
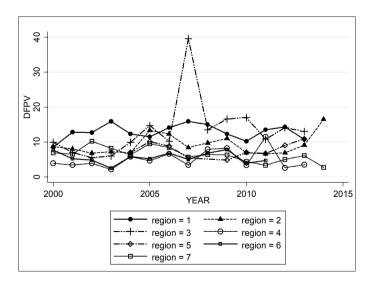

Figure 3 - DFPV over the Time.
Region 1, 2, 3,4,5,6 and 7 represent Central Asian, Eastern Asian, South Asian, Southern Eastern Asian, and Western Asian, African and South American countries respectively.

The Domestic Food Price Index (DFPI) calculated by the Food and Agricultural Organization gives the relative price of food in a country. Figure 4 shows how this index varies over time in the selected regions. It is clear that in all regions the price index increases. The increase is sharp in the Western Asian region than others.
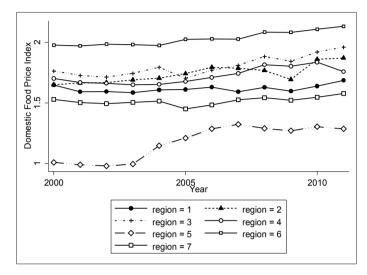

Figure 4 - DFPI over the time.
Region 1, 2, 3,4,5,6 and 7 represent Central Asian, Eastern Asian, South Asian, Southern Eastern Asian, Western Asian, and African and South American countries respectively.

Per Capita Food Supply Variability (FSV) also has unpredictable high changes over time in all regions. Western Asian countries such as Iraq, Jordan, Kuwait etc. (Region 5) has a high value as 80 (kcal/day) in 1993 and after that it declined to 16 (kcal/day) in 1996 (Figure 5). However, there is a general declining trend in FSV in all regions: end of study period variability in food supply is lesser than the beginning of the study period variability. Thus, is seems that supply risks reduces over time.

Results from the GLS estimation

The 'xtgls' procedure in STATA (Version 12) is used in estimation and the results are in Table 1. The low p-value reported in the chi-square test confirms that the model is significant at 95 % confidence level and the Mean Square Error (MSE) is reasonable (Table 1). As expected, the Gross Domestic Product per Capita (GDP) is negative indicating that the rise in income would relate to a lower depth in food deficit. In other words, higher the national income higher the food access. Although, a country's GDP is a measure of its wealth, it may not necessarily be a measure of wealth of all inhabitants. Therefore, there still may be distributional issues of income within the country (Stockhammer *et al.*, 1997).

Table 1 - Outcome of the Regression Analysis.

Variable	Coefficient	Standard error	Z	P -value
GDP	-0.004*	<0.000	-11.390	<0.000
Calorie Loss at Retail Level (ICL)	15.130*	2.762	5.480	<0.000
Domestic Food Price Volatility (DFPV)	0.251*	0.123	2.050	0.041
Per Capita Food Supply Variability (FSV)	0.120*	0.057	2.110	0.035
Value of Food Imports over all Imports (FIOE)	-0.066*	0.018	-3.640	<0.000
Domestic Food Price Index (DFPI)	45.559*	6.006	7.590	<0.000

*Significant at 5% error, Prob > chi-squared = <0.000, MSE=8020.08

The Incidence of Caloric Loss (ICL) at retail distributional level show a positive relationship with the depth of food deficit indicating that loss lead to food insecurity. A one percent reduction in ICL at retail level can reduce depth of food deficit by 19.5 kcal/caput/day. Average values for ICL in percent for African, Asian and American countries represent 4.3, 2.5 and 3.4 respectively from 1992 to 2014. So, a one percent reduction in loss at retail level may have a remarkable impact on reducing the depth of food deficit in these countries leading to increases in food security. This is one area overlooked in the extant literature on improving food security. Even in a developed nation such as the United States, an estimated 31 percent or 133 billion pounds of the 430 billion pounds of food produced was not available for human consumption in 2010 indicating the magnitude of food loss (Buzby *et al.*, 2014).

Domestic Food Price Volatility (DFPV) is also show a positive and significant effect on the depth of Food Deficit indicating that higher the volatility, higher the depth of food deficit and therefore, access to food becomes an issue. There is also a positive relationship of Depth of Food Deficit with Domestic Food Price Index (DFPI). Price and its volatility has a strong impact on food security, because it affects household income and purchasing power. High and volatile prices is a challenge for policy makers. Variation in food prices is an issue when they are large and difficult to anticipate and, as a result, create an uncertainty that increase risks for producers, traders, consumers and governments leading to less than optimal decisions (Sulaiman, and Kandakov, 2015). Volatility in prices generate uncertainty about the "true" price level for producers and consumers, and therefore the production and consumption decisions may be different from what would have been the case under the stable prices (Diaz-Bonilla and Ron, 2010).These results indicate that high and variable food prices is detrimental to accessibility to food. In the households of developing countries, food takes a large portion of their cash expenditures. Therefore, they try to

reduce their outlay on such items as transport, health and education as food becomes expensive. Thus, households are likely to adjust their food consumption. Families can reduce food expenditures by eating less, skipping meals or shifting to lower quality food or less diverse diets. Such changes in consumption patterns due to high prices may lead to higher micronutrient deficiency disorders and a greater incidence of disease, child and maternal mortality, poor school performance and over time, reduced worker productivity (Cohen and Garrett, 2010).

Apart from high and variable prices, another kind of shock is the variability in supply, captured by the Per Capita Food Supply Variability (FSV). This also has a significant and positive impact on Depth of the food deficit (DFD) which means that higher the volatility in supply risk of increased food deficit is greater. Therefore, it is important for a country to be food secure, its food price and supply variability to be less. The FSV has been higher in recent years in Central and South Asian nations and lowest in the South American region (Figure 5). Fluctuating output can have a detrimental impact on food security by making it difficult to manage food supply. High volatility can create unnecessary surpluses or shortages that severely affect food availability. Affordable food has less value if access to it is difficult, volatile or uncertain (Global food security index, 2015). As global populations expand, ensuring that enough food is available and affordable requires that productivity in food production improve. Otherwise, there will be more individuals chasing ever-scarce food leading to higher prices, lower availability and food insecurity for some (Alston *et al.,* 2009).

Value of Food Imports over Total Merchandise Exports (FIOE), which captures the adequacy of foreign exchange reserves to pay for food imports, has significant and negative impact on Depth of the food deficit implying that, a country's adequate foreign exchange resources may ensure food security.

Given the importance of these covariates on the depth of food deficit and hence the accessibility to food, elasticity of these covariates are recorded in Table 2. According to Table 2, most detrimental to access to food is price increases as indicated by elasticity values of domestic food price index. This is true for all regions. A country's foreign exchange reserves (as indicated by the value of imports) does not adequately offset this detrimental effect of domestic food prices on depth of food security. International food prices have surged at a fast rate since mid-2010, and in January to May 2011 and they had exceeded the peak recorded in 2008 (Cornia *et al.*, 2012). These will pass onto domestic food prices. Because climate play a role in agricultural production, food prices may rise in the future due to climate change (Bandara and Cai, 2014). Reducing food price variability will have a similar impact in all regions with slightly higher values in the East Asian and African Samoa.
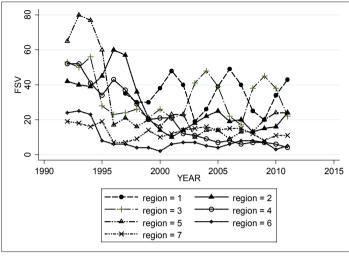
Figure 5. FSV over the time.
Region 1, 2, 3,4,5,6 and 7 represent Central Asian, Eastern Asian, South Asian, Southern Eastern Asian, and Western Asian, African and South American countries respectively.

Highest response for a change in GDP in the reduction of food deficit is in the East Asian region. A reduction in calorie loss at retail level will increase access to food in Latin American and East Asian nations in greater proportion than other regions. Elasticity values calculated show that a one percent reduction in calorie loss through supply chain can increase access to food in greater manner than increasing national income by one percent. For example, reducing calorie loss in the African region by 10 percent would lead to a 3.05 percent reduction in depth of food deficit whereas a 10 percent increase in national income would lead to a reduction of only a 0.6 percent of food deficit. The impact of reducing calorie loss is greater than the impact of increasing national income in all other regions as well.

Table 2 - Elasticity values for various regions derived from the regression estimation.

	REGION						
VARIABLE	SOUTH ASIAN	CENTRAL ASIAN	EAST ASIAN	SOUTH EAST ASIAN	AFRICAN	AFRICAN SAMOA	LATIN AMERICAN
GDP	-0.12	-0.23	-0.40	-0.21	-0.07	-0.28	-0.36
CLRL	0.32	0.29	0.42	0.34	0.31	0.34	0.46
DFPV	0.02	0.02	0.03	0.02	0.02	0.03	0.02
PCFSV	0.03	0.08	0.02	0.03	0.03	0.02	0.04
VFI	-0.01	-0.01	-0.00	-0.00	-0.02	-0.02	-0.00

CLRL= Calorie Loss at Retail Level; DFPV= Domestic Food Price Volatility; PCFSV= Per Capita Food Supply Variability; VFI= Value of Food Imports over all Imports; DFPI= Domestic Food Price Index

Conclusions

Using panel data from 2000 to 2011, the impact of food price on food access and availability in 71 countries in the world was analysed using a Generalised Least Square model. The outcome of this analysis shows that food price and its volatility negatively affect food security. It means that, if price and supply of food products vary over time then, food availability and accessibility become a big issue for all. Apart from food price rises, loss incurred though food supply chain contribute significantly to lack of accessibility to food. Of the variables studied, food prices have the greatest impact on access to food. Interestingly, calorie loss at retail level pose a significant threat to access to food even in greater proportions than that of low income. This finding is noteworthy as it is easy to put policies and practices in place to rectify and reduce food loss at retail level.

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