FOOD SECURITY INDEX FOR TAJIKISTAN

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Abstract: Food security of a nation gets affected by many factors. This papers attempts to develop an index that indicates how food security situation is likely to change given the changes in these underlying factors. With such an index, the policy makers can get an early warning signal as soon as the underlying factors change. If two opposite forces change together, the index might show that there is no need for any action because the change in one has been taken care of by the change in the other. Tajikistan is taken up as a case study to try out this index.

Index terms: Tajik economy; food security in Tajikistan; food security index, regression for Tajik food security.

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I. Background:

Tajikistan was separated from the Soviet Union in 1991. Two groups claimed control over the government: The Islam fundamentalists and the Liberalists. A civil war ensued that lasted for almost five years. The general population was in support of the Liberal government. After many casualties, the Liberals won the war. Peace returned to Tajikistan by 1997. It was only after 1997 that the country could concentrate on development.

The path to development was not easy. As a part of Soviet union, Tajikistan's main contribution was cotton. The whole arable land was used mainly for growing cotton, because Tajikistan was a suitable agro-climatic region for the crop. The Soviet system enabled the region to grow high quality cotton; in 1980s it boasted of one of the highest yields in the world (USAID: Feed the Future, 2012). Still, the revenues from cotton and other resources were not enough to support the Tajik economy during the Soviet era. Tajikistan remained the net receiver of subsidies from USSR (Amir and Berry, 2013). Such financially dependent region had to struggle hard to become an economically strong and viable state after gaining independence.

Despite economic dependence on USSR before independence, the status of human development was high in Tajikistan at the time of independence. During the Soviet era, Tajikistan had achieved almost universal education (with literacy rates as high as 99%), full employment, and free universal health care. During the Soviet era, wheat was supplied by Russia but these human development factors also helped in enhancing food security for the Tajik people by ensuring employability, steady flow of income and ability to retain the energy derived from food because of good health.

The new government that took control in 1997 was not yet financially strong. The Soviet social support systems in health and education remained but could not be maintained well. The quality of education dropped (Wikipedia: Education in Tajikistan). Thus people became literate or degree holders but that did not ensure their employability. Also, the job situation deteriorated substantially – agriculture was not earning enough returns and industrial growth was negligible – there were very few jobs available. These problems haunt Tajikistan even now.

Furthermore, with only 6% of its total land being arable, producing food for the growing population becomes a major challenge. Prior to 1991, the food was supplied from the Soviet Union. Now Tajikistan depends considerably on imports for its food supplies (Akramov and Sreedhar, 2011). Thus food insecurity is one of the major challenges that the country faces (Jones and Hoover, 2014).

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1.1. An index for influencing factors

There are some underlying factors that affect food security situation in a nation. It is important to know beforehand what these factors are and how much impact their change can have on food security. A model should clearly indicate the quantitative impact of each of these factors. Such model can intimate the policy makers about the likely changes in the hunger situation given the changes in the underlying factors. Preventive steps can be taken accordingly.

Often, the underlying factors work in opposite directions – increase in food and fuel prices can adversely affect food security but increase in income or foreign aid can enhance it. We feel that an index that sums up the total impact of such variables and indicates the direction of change in the food security situation can be useful in giving out warning signals to the policy makers.

There are already some food security indices like Global Hunger Index (GHI). However, GHI only gives an estimate of the actual undernourishment and hunger. The FAO Index of Global Food Security looks at 25 indicators that describe affordability, accessibility and quality of food. Though it is a comprehensive index in many ways, it does not capture the national level risks and forces that result in food insecurity. Moreover, it does not always capture the most important variables that affect food security. In this paper, we have developed an index that reflects the changes in the explanatory variables to indicate likely changes in the food security. Such an index would be country specific because factors affecting food security are different for each nation.

The following section identifies important factors that affect food security in Tajikistan. These would be included in the model as explanatory variables. The third section reports the results of regression models that quantify the effect of the explanatory variables. The index is described in the fourth section. The last section concludes the paper.

II. Factors affecting food security situation in Tajikistan

2.1. Agriculture Production

Agriculture still occupies an important place in Tajik economy. Although only 22-27% of the GDP comes from agriculture, 55% of the population is still estimated to be employed in agriculture. Other 18% of the population that resides in rural areas has many direct and indirect links with agriculture. (World Bank Development Indicators).Thus agriculture production is closely related with food security for the majority of the Tajik population.

As part of Soviet Union, Tajikistan specialized in growing cotton. For this, extensive network of irrigation system was created. During the civil war, this network was affected and since then, many parts of the system broke down or crumbled. The network needs to be repaired and maintained. In the absence of a well-functioning network, agriculture suffers from scarcity of water (Jones and Hoover, 2014). Other inputs such as agriculture equipment, fertilizers and good quality seeds used to be provided by the Soviet government. Now such supplies have stopped. At present, there is limited access to agriculture finance for farmers to acquire these inputs. Such constraints led to considerable fall in agriculture productivity.

The government is trying to overcome these challenges and increase both the agriculture productivity and total production through further reclamation of land. The Law on Food Security in Tajikistan, 2010, aims at having foodgrain production in the country to be not less than 80% of the total needs of the population.

As Table 1 shows, the food production started increasing from 1998 and has grown by 169% by 2013. The poverty levels have declined over this period and the food security situation has improved.

Table 1: Food production index for Tajikistan

Year	Food Production Index (2004-2006 = 100)
1992	90.77
1993	81.01
1994	82.04
1995	77.18
1996	63.66
1997	63.96
1998	57.95
1999	60.94
2000	71.96
2001	75.14
2002	83.84
2003	88.66
2004	102.14
2005	98.24
2006	99.61
2007	102.87
2008	108.96
2009	118.37
2010	122.65
2011	132.29
2012	143.81
2013	155.73

Source: http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators#;

2.2. International trade

Tajikistan was always dependent on imports for meeting the food requirements of its population. More than 50% of cereals, 30% of bovine beef, 80% of poultry products, three-quarters of vegetable oils and most of sugar consumption in Tajikistan rely on imports (Akramov and Sreedhar, 2011). Tajikistan has also been dependent on imports for its fuel supply. Table 2 shows that petrochemicals form the most important part of the Tajik imports (13.7% of the total imports) followed by wheat (6.4%) in 2013. If the fuel or grain prices increase, Tajikistan's capacity to import these products diminishes, leading to rise in food insecurity.

Table 2: Composition of international trade (2013) - Tajikistan

Items exported	% of total exports	Items imported	% of total imports
Raw aluminium	59	Refined petroleum	7.3
Raw cotton	12	Other footwear	5.0
Lead ore	3.8	Wheat	4.1
Other ores	3.7	Petroleum Gas	3.8
Dried fruits	3.6	Knit women's suit	3.2
Zinc ore	3.1	Crude petroleum	2.6
Non retail cotton yarn	2.0	Wheat flour	2.3
Copper ore	1.9	Sawn wood	2.3
Non-knit Men's suits	1.6	House linen	2.2

Source: http://atlas.cid.harvard.edu/country/tjk/

Tajikistan Government plans to move towards more balanced international terms of trade. But given the country's natural resource base (it has very little arable land and no oil), this is likely to happen more from increased exports than decreased imports. The main export products of Tajikistan (see Table 2) are aluminium and cotton: 59% of the exports were made up of aluminium in 2013 and 12% were of raw cotton. 12.5% was made up of other ores like lead, zinc and copper. The balance of trade for Tajikistan is critically dependent on the prices of these products - the movement in prices of these products determine the country's ability to earn foreign exchange for its imports.

The prices for both cotton and aluminium have been declining in the recent years. On the other hand, fuel prices also decreased sharply in the past few months. But the overall balance of trade has deteriorated in last few years.

2.3. Food Price

As Tajikistan imports a large proportion of its food requirements, the international prices of these items have a direct impact on its food security. This factor is taken separately from the balance of trade to emphasize its importance for food security. The FAO food price index has been used to represent the food prices in the international market. The index includes prices of cereals, meat, dairy, vegetables and sugar to reflect the change in food prices.

As Table 3 shows, there was a sharp increase in the food prices in 2008 followed by a decline in 2009. Another sharp increase came in 2011. The prices have been coming down from that level since then. But there is significant volatility in the food prices that could have affected food security.

Table 3: Movement of food prices – FAO price index

Year	FAO Food price index
2000	91.1
2001	94.6
2002	89.6
2003	97.7
2004	112.7
2005	118
2006	127.2
2007	161.4
2008	201.4
2009	160.3
2010	188
2011	229.9
2012	213.3
2013	209.8
2014	201.8

Source: http://www.fao.org/worldfoodsituation/foodpricesindex/en/

2.4. Inflation rate

The inflation rate reflects many factors like changes in domestic output, changes in international prices, and changes in incomes. It is a composite indicator that includes the impact of many underlying economic events. Also, the price index like CPI shows how much the Tajik population pays for its needs. Therefore it is a crucial factor to include in the analysis because it reflects the overall affordability.

As Fig. 1 shows, inflation rate was as high as 33% in the year 2000. It was reduced in the next few years and by 2005, the inflation rate was in single digit. However, the recession affected the economy adversely and the inflation rate shot up again in the year 2008. After coming back to the manageable levels of around 5% in 2009, it again rose to double digits in 2011. It has been under control since then. However, such volatility in prices must have affected the food security situation in the country.
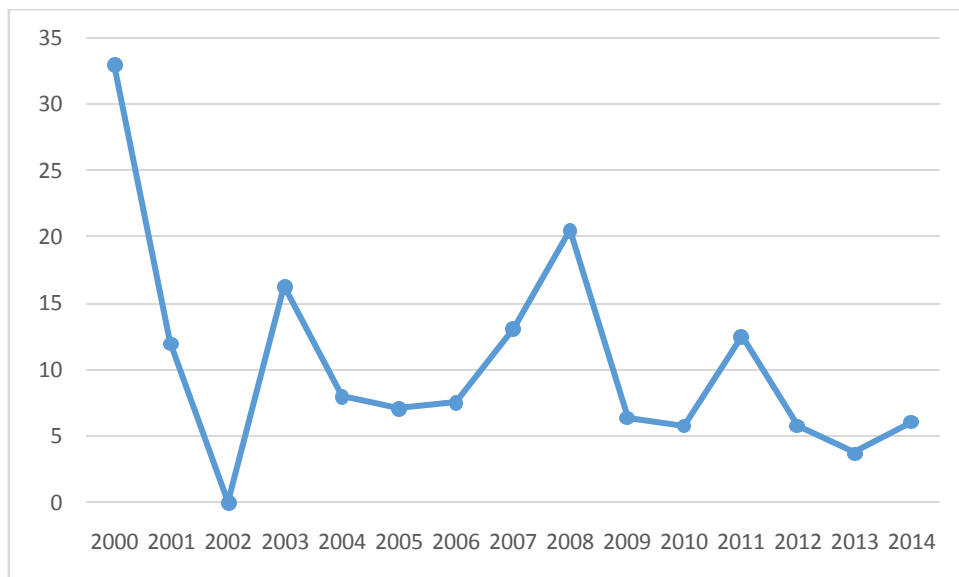
Figure 1: Average annual inflation rate in Tajikistan,percentage
Source: http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators#;

2.5. Population:

Starting from the Soviet era, population has been growing at a very high rate in Tajikistan. In 1980s, the growth rate wasaround 3% Table 4). It declined to about 2.4% by 2014. Still the population growth rate is one of the highest in the region and is considered very high by the international standards. Such high rates of population growth put pressure on the food security situation. Attaining self-sufficiency in food for a nation also gets affected.Hence this factor needs to be considered while assessing the food security situation.

Table 4: Population growth in Tajikistan

Years	Annual population growth rate
1960	2.79
1970	2.97
1980	3.11
1990	3.46
2000	1.86
2005	2.08
2010	2.36
2013	2.38

Source: http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators#;

2.6. Poverty:

In 1999, 50.08% of the population lived on less than $ 1.25 a day (Table 5). This number declined to 6.47% in 2009. The population living with incomes less than $ 2 a day was 82.24% in 1992 and came down to 27.36% in 2009. Thus poverty has been declining at a fast pace – the absolute poverty decreased by 87% in last ten years. It is expected that gains in nourishment would accompany such decline in poverty. Thus poverty has to be considered as an explanatory variable.

The national poverty figure estimated 96% of the people living below the poverty line in 1999 and 47% in 2009, but population suffering from chronic hunger must be close to the absolute poverty figure measured by percentage of population living below the $1.25 poverty line – which is 6.47%. The Tajikistan Demographic and Health Survey conducted by USAID in 2012 finds 3% of the sampled women severely thin and 8% mildly thin. 10% of the children are reported to be severely malnourished. The problem of having no food seems to less prevalent than the problem of lack of balanced diet and in-take of sufficient amount of micro nutrients.

The Millennium Development Goals Tajikistan Progress Report (2010: page 14) shows that the protein consumption far lags behind the dietary norms in Tajikistan and the carbohydrates consumption is far above required. The overall calorific value of the food is also not enough. The poor seem to have avoided malnutrition by relying onlow quality and low priced diet. Inclusion of richer food products in the carbohydrates dominated diet is

recommended. In short, Tajikistan seems to need improvements in quality of food consumedover the quantity of such food.

Table 5: Percentage of poor in the population (for population living on less than $1.25 per day)

Year	% of population living below the poverty line
1999	50.08
2003	35.42
2004	20.7
2007	12.18
2009	6.47

Source: http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators#;

In 2013, 26% of the population was residing in the urban areas whereas 74% was living in the rural areas. Given that the rural population depended mainly on agriculture sector for employment and where the productivity is low, poverty was found to be more prevalent in rural areas than urban. The rural-urban poverty gap is found to be 5.6% (Millennium Development Goals Tajikistan Progress report, 2010).

2.7. Employment situation and remittances

Employment opportunities are limited in Tajikistan. It is predominantly an agriculture based economy but the sector cannot generate much revenue for the economy.In fact, WFP bulletin reports that the households whose incomes come mainly from agriculture and have no other source of income are most likely to be food insecure.

Industry employs only 17% of the total population. Service sector supports around 26% of the workers (World Bank Development Indicators). This is because the industrial base is very limited: Tajikistan has industries only for aluminium, cement and vegetable oil (Jones and Hoover, 2014). In the absence of much development in both agriculture and industrial sector, the service sector is also not buoyant. People do not have much opportunity for employment. They have to look for work beyond Tajikistan.

As WFP reports in its February 2015 Bulletin, over a million of Tajikistan's 8.2 million workers work abroad as labour migrants, mostly in Russian Federation. Remittances formed just 6.43% of the GDP in 2002; its contribution increased to 47.5% in 2012 (World Development Indicators), making it the country most reliant on remittances in the world, as the WFP Bulletin reports.

However, since 2014, the remittances have started to decline. Entry denials and Russia's economic slowdown are reported by WFP bulletin as major factors impeding labour migration from Tajikistan to Russia. The labour outflow has been reversed – many workers have returned back to Tajikistan in first half of 2015. This has added to the food security crisis.

Table 6: Remittances received as % of GDP

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Remittances	6.4	9.4	12.1	20.2	36.0	45.5	49.3	35.1	40.9	46.9	47.5

Source: http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators#;
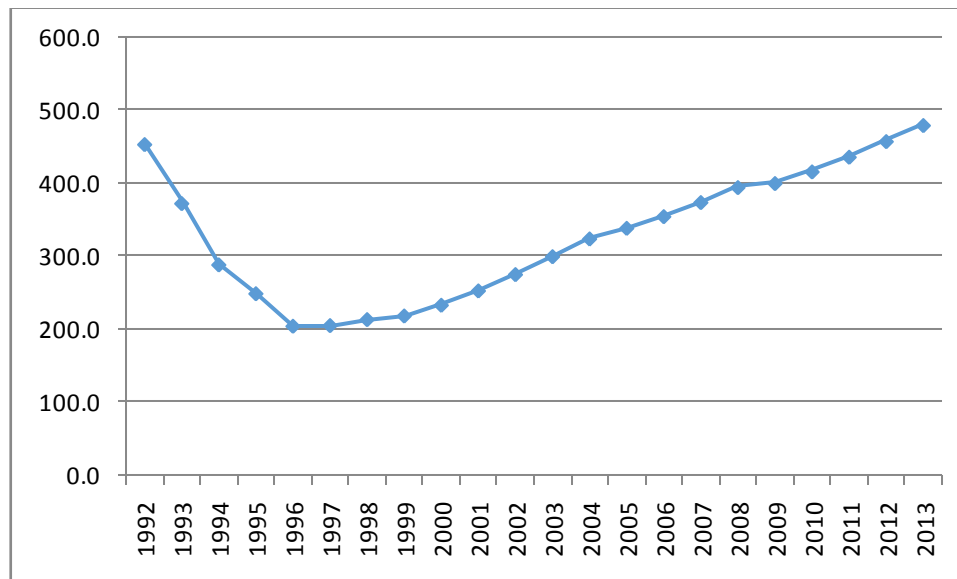
2.8. Economic Growth

Figure 2: Tajikistan's GDP per capita in constant 2005 USD
Source: World Bank Development Indicators

As explained earlier, the civil war affected Tajikistan for first five years of its independence. The national income declined considerably during this period. As the graph shows, it took the country many years to just reach back to the income levels of the Soviet era – in 2011, the incomes came back to the level of 1991.

The economy grew at the average rate of 7.6% from 1997 till 2013. The global economic crisis `of 2008 in the western world affected the Tajik economy also; the growth rates declined to 3.8 and 6.5% respectively for the years 2009 and 2010. The economy recovered again to grow at around 7.5% annually from then onwards.

The UNDP/Republic of Tajikistan Report on Millennium Development Goalsreports that economic growthinthecountry seems to be directed towards poverty reduction.Theper capitaincomeof20% of the poorest and richest population groupsincreasedby 13.6% and5.7% respectively. It quotes surveys to show that economic growth is the main determinant of poverty reduction although opines that most probably this happened due to the remittances received from migrant workers.

III.   Statistical Analysis

3.1. Factors included for the statistical analysis

This paper is an effort to quantify the effects of different variables that have been identified above as important in determining the food security situation in Tajikistan. Secondary data reported by World Bank, FAO, Index Mundi are used for the regression analysis. GDP per capita, CPI, remittances, people undernourished variables were taken from the World Bank development indicators (http://www.worldbank.org) and cereal consumption per capita, wheat imports variables were extracted from the FAO tables (http://faostat.fao.org)and US crude oil prices were taken from Index Mundi resources (http://www.indexmundi.com).

Among the indicators of malnutrition, the indicators were selected based on two criteria:
1. Continuous and reliable data should be available
2. It should be able to capture small changes in the economic situation.

The IMR and life expectancy change slowly; hence they do not reflect the small changes in food security situation. The poverty data is sensitive to small changes in the economic situation, but is not continuous and is available only for a few years. Thus it is not amenable to statistical analysis.

Cereals consumption per capita and percentage of people undernourished are two indicators for which continuous data is available and they change as the economic situation changes. From the year 2002 to 2012, we find that they are

very closely correlated with each-other(r = 0.86). Therefore, it was decided that any of the two could be used as dependent variable to represent the level of food security in the country.

As an explanatory variable, food production index was not useful. As food production increased, we found that cereal consumption actually declined! The explanation could be found in the pattern of consumption of cereals: the families that have started receiving remittances and hence experienced increase in incomes might have increased the consumption of nutritionally richer (but more expensive) foods like meat, milk, fruits and vegetables. This might have led to some decrease in cereal consumption. As figure (3) shows, the cereal consumption per capita has indeed declined slightly over the years. However, food production has increased. Hence the correlation is not well established between production and consumption.
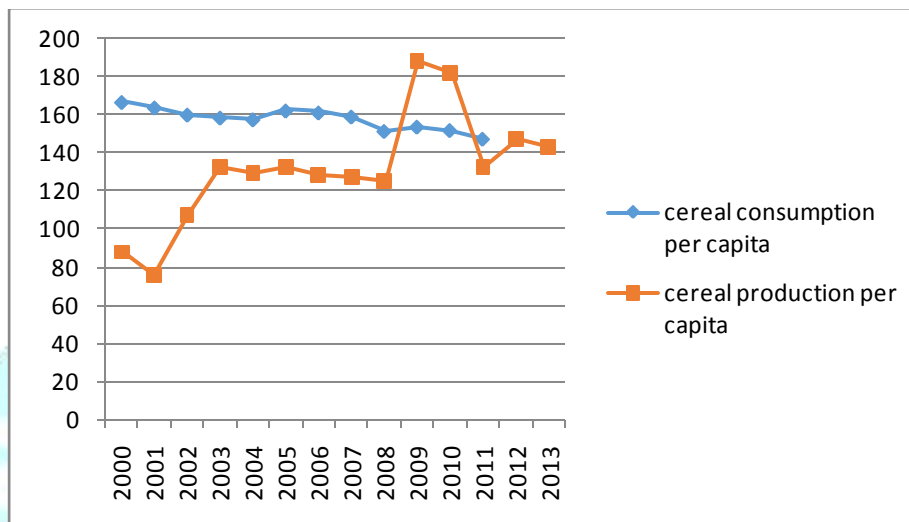

Figure 3: Cereal consumption and production in Tajikistan (2000-2013)
Source: faostat.fao.org

When cereal consumption declines due to higher living standards, it does not correlate with the population growth rate either. Moreover, population growth does not seem to have created considerable impact yet on food security because even the indicator of percentage of people undernourished does not show much correlation with the population growth rate. Thus, although the concern regarding the high rate of population growth is valid and can worsen the food security situation, the data trends are not able to demonstrate it.

Tajikistan is prone to natural disasters – mainly related with rains – floods, landslides and droughts. The food security is affected by such disasters. It is an important explanatory variable However, annual rainfall data for last 10 years or more was not found. Most give just the average figure for 10 years. Therefore, any statistical relationship could not be established for this variable.

Cotton and aluminium are most important export items for Tajikistan. The changes in prices of these items affect the balance of trade and hence the capacity of Tajikistan to import wheat and oil. However, the relationship between food security and aluminium/cotton exports is not direct and that gets reflected in poor correlation that the two have with food insecurity. That is why these variables also do not appear in our statistical analysis.

On the contrary, wheat imports have direct relationship with food security in Tajikistan. We found significant negative correlation between the wheat import price and food security indicators. Similarly, fuel prices also showed significant negative correlation with cereal consumption and percentage of population undernourished. Other variables, explained in the earlier section, like per capita income, remittances and inflation rate are also found to be important explanatory variables.

3.2. The regression model:

The regression result for full 21 years was decided not to be used because:
(a) There was a strong influence of an external factor – civil war – that made the behaviour of domestic crude oil prices and inflation erratic
(b) It could not include remittances as an explanatory variable because of unavailability of data for the first 11 years and this overemphasized the impact of GDP.

The multivariate equation faltered for the 10 year data - may be due to the degrees of freedom problem. We tried out regression models with fewer variables (Table 7). The dependent variable was taken to be "percentage of population undernourished". The explanatory variables for individual equations were GDP, remittances, crude oil price, wheat imports per capita, CPI, and time. The results were encouraging with R square always more than 0.7 for each result and all the t-statistics being significant at 1% level.

Table 7: Results of regression equations

Variable names	B	T
GDP	-0.320	-4.022
Remittances	-0.061	-3.976
Us crude oil price	0.109	2.733
Wheat imports per capita	-0.255	-2.986
CPI	0.390	2.552
Time	0.017	4.734

(where

GDP – GDP of Tajikistan per capita in constant 2005 prices, USD per capita

Remittances – Remittances to Tajikistan in constant 2005 prices, USD per capita.

US crude oil price – simple average of 3 spot oil prices; Dated Brent, West Texas Intermediate, and the Dubai Fateh, USD per Barrel.

Wheat imports per capita – wheat imports of Tajikistan per capita,

CPI – Consumer price index of Tajikistan in constant 2010 prices, %.

Time – 1, 2, …, 11.)

GDP showed significant adverse relationship with the percentage of people undernourished. In other words, as incomes increased, undernourishment declined.

Remittances were also found to be significantly reversing the undernourishment. US fuel prices were positively correlated to percentage of people undernourished; as increased fuel prices affect the transportation costs and in turn, reduce the accessibility of grains to the population, leading to increased undernourishment.

Increase in CPI increases undernourishment. As explained earlier, global price volatility has been affecting the Tajik economy adversely. It has impacted domestic prices. Similarly, the reduced food production caused by natural disasters would add to the inflation. Prices are the mirror of the events happening in the economy. CPI captures almost all factors that affect the Tajik economy. Our model shows that when the Tajik economy suffers from such external price shocks, the impact is also strongly felt on the nourishment levels of the population.

Because Tajikistan is not self-sufficient in food and is mostly dependent on wheat imports for maintaining its food security, the impact of wheat imports was also examined. We found that as wheat imports per capita increased, the number of undernourished people decreased.

Although the above analysis shows individual relationship of each variable with the dependent variable and not its relative importance vis-à-vis other variables, it is able to provide some estimate of the quantitative importance of each variable in explaining the variable *percentage of people undernourished*. Inflation and economic growth (represented by CPI and real GDP respectively) turn out to be the most important determinants of undernourishment in the population. Unlike the UNDP millennium Development Goals report which emphasizes the importance of remittances in improving the conditions of the poor over other factors, our regression gives lesser weight on remittances compared to overall development of the economy.

IV. Building an index of food insecurity

Quantification of factors influencing food security in Tajikistan was aimed at making an index that reflects the food security situation in just one digit. Its movement up and down sends out the signals to the stake holders about the consequences of change in forces that affect the food security. It show show much the food security situation could change given the changes in each underlying factor. Thus it sends out the warning signals if these forces change to significantly affect the food security situation.

The usual food security indices are based on the indicators of health and human development (like IMR, MMR, underweight children, anaemic mothers and such); on the contrary, this index is based on the *factors that affect* these

malnourishment indicators. So it would not only show the changes in food security situation but explain it. It is thus more effective for sending warning signals for the government to take action.

The index was built using the coefficients derived from the regression analysis as weights for the values of the explanatory variables. A weighted sum of these variables was then calculated for the dependent variables – cereal consumption per capita and percentage of population undernourished – for each year. The index numbers were calculated taking year 2002 as the base year.

The base values for the index were derived by the following equation:

Percentage of population undernourished base value = (-0.32*real GDP per capita) - (0.061*remittances per capita) + (0.109*fuel price index) + (0.390*consumer price index) – (.255*wheat imports per capita).

The index was closely reflecting the increase and decrease in *percentage of people undernourished* while deriving its value from the factors influencing the food security situation. When these factors change for the better, the food security index would increase and vice versa. Figure 4 shows the relationship between the index numbers derived from the explanatory variables and percentage of population undernourished. It shows how the decline in the percentage of population under nourished is closely related to the improvement shown in the index. The correlation coefficient between the two is -0.957.
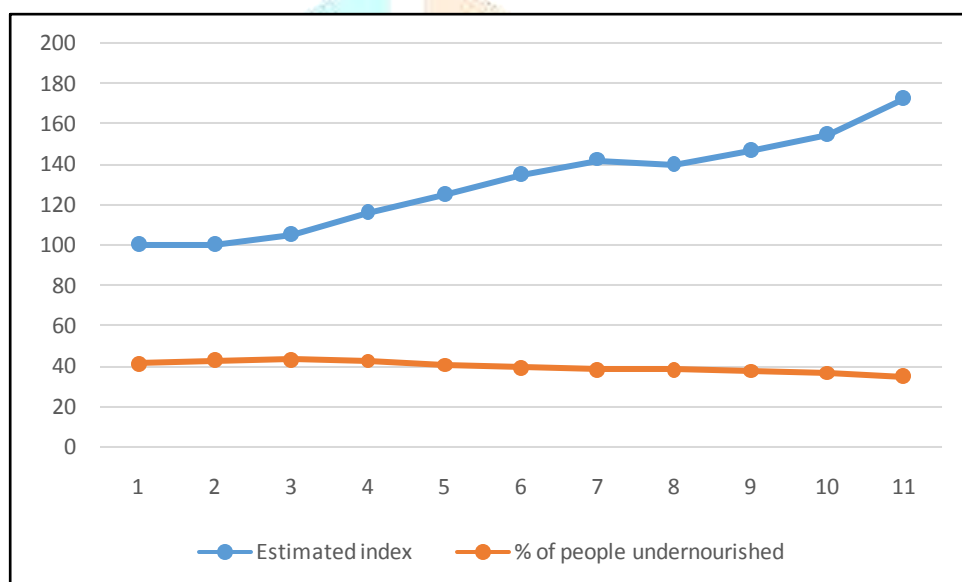

Figure 4: Comparison between estimated index of undernourishment and % of people undernourished
Source: FAO and authors

As mentioned earlier, the advantage of this index is that when it goes down, unlike the usual indicators of malnourishment, it would not only show the direction of change but also explain the factors responsible for the worsening food security situation. But just like the CPI basket, this index would also need to be redefined as the factors determining food security change over years.

V. Conclusion:

A food security index described above can send out signals to the government whenever the forces affecting food security change adversely to affect the hunger levels. Such signals would be very useful in taking preventive action. The government can act immediately when it sees a decline in the index – this way it would be able to prevent the hunger from spreading. Measures can be taken to counter the effects of the underlying forces.

The index would be just a number so it would be easy for the bureaucrats to understand. They would know when the safety nets would be needed. At the same time, the mechanics of the index would enable the economists to identify the factors that are causing an increase in food insecurity. Steps can be taken to counter the effects of such forces.

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