

# **Food Inflation, Underemployment and Hunger Incidence: A Vector Autoregressive Analysis<sup>1</sup>**

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The high level of hunger incidence in the country is perhaps one of the most pressing issues that need to be addressed by our policymakers. Official government statistics and data from self-rated hunger surveys show an increasing trend in hunger incidence among Filipino households. Data from the National Statistical Coordination Board (NSCB) show that the percentage of Filipinos experiencing hunger almost remained the same, decreasing only slightly from 11.1 percent in 2003 to 10.8 percent in 2009. The Social Weather Stations (SWS) quarterly surveys on hunger incidence also show an increasing trend in the percentage of families that experienced hunger, reaching an alarming level of 24 percent in December 2009, representing about 4.4 million households. One probable cause of the increasing trend in hunger is the rising food prices akin to what the country experienced in 2008. This paper aims to determine the impact of food inflation and underemployment on hunger incidence in the Philippines, using the hunger incidence data from the SWS. A vector autoregressive (VAR) model is used to determine the effect of a shock or increase to food inflation and underemployment on total involuntary hunger. Results show that an increase in food prices at the current quarter will increase hunger incidence for five quarters. Shocks to underemployment will also increase hunger incidence but the effects last for only two quarters. The results of this study provide relevant information that will be useful in crafting policies related to the Hunger Mitigation Program of the government.

*Keywords: hunger, food inflation, underemployment,  
vector autoregressive*

## 1. Introduction

Pope Benedict XVI, during a summit of the United Nations Food and Agriculture Organization (FAO) in November 2009 in Rome, referred to hunger as “the most cruel and concrete sign of poverty.” The pontiff has reason to worry. World hunger reached a historic high in 2009 with 1.02 billion people experiencing hunger every day, according to estimates from the FAO. The number of individuals going hungry has reached the one billion mark for the first time in history. This represents about 15 percent of the world’s population, estimated at 6.8 billion in 2009. The twin crises experienced in the past two years, the high cost of food in 2008 followed by the global financial crisis, increased the number of individuals who went hungry by about 100 million compared to the 2008 estimates of 915 million.

In the Philippines, hunger incidence in its various absolute dimensions, has been widespread and increasing in recent years, threatening to rip our social fabric. It is disturbingly high and embarrassing, in comparison to other countries in East and Southeast Asia. The food crisis, in 2008, resulting from high prices of basic commodities particularly rice, the global financial crisis and the impact of natural calamities (brought about by typhoons Ondoy and Peping) in 2009 are expected to raise the number of Filipinos who will join the ranks of those experiencing involuntary hunger. While these three shocks in the past two years will exacerbate further the poverty and hunger situation in the country, it will not fundamentally change the character of the poverty problem in the country (Balisacan and Mapa, 2010). Evidence from official statistics and national surveys of hunger by the Social Weather Stations (SWS) suggest that our country’s hunger situation has already deteriorated during the period 2003 to 2008. What is disturbing is that the worsening problem of extreme poverty occurred against the backdrop of high growth rates as trumpeted by the past administration of Gloria Macapagal-Arroyo.<sup>2</sup> Undeniably, addressing the problem of hunger or extreme poverty is the single most important policy challenge facing the country today.

Our official statistics on the proportion of subsistence poor compiled by the National Statistical Coordination Board (NSCB) reveal a number of striking observations. First, the percentage of subsistence poor (or food poor) did not change much in recent years, only slightly decreasing from 11.1 percent in 2003 to 10.8 percent in 2009. However, in terms of magnitude, the number of food poor Filipinos has increased to about 9.44 million in 2009 from 8.8 million in 2003. This is primarily because of the relatively high population growth during the period.<sup>3</sup>

The results of the 7<sup>th</sup> National Nutrition Survey (NNS) of 2008 conducted by the Food Nutrition and Research Institute (FNRI) show there was a significant increase in the proportion of children aged 0-5 years who were underweight (indirect measure of hunger) from 24.6 percent in 2003 to 26.2 percent in 2008. Moreover, the same report shows that the proportion of children who were under height for age

(stunted) also increased significantly to 27.9 percent in 2008 from 26.3 percent in 2003. The FNRI study also shows the same results in children between 6 to 10 years old: a significant increase in the prevalence of underweight from 22.8 percent in 2003 to 25.6 percent in 2008 and increase in the proportion of under height from 32.0 percent to 33.1 percent.

Given the inadequate progress in reducing the number of households living below the subsistence or food threshold and in minimizing the number of underweight children, the Philippines will most likely miss its Millennium Development Goal (MDG) target of halving the proportion of poor households living below the food threshold and halving the proportion of underweight children below 5 years old from 1991 to 2015.

The SWS national surveys on hunger also show that the hunger incidence in the country has deteriorated in the past years. The proportion of families experiencing involuntary hunger reached a record-high of 24 percent in December 2009, representing about 4.4 million households (SWS, 2010). The time series data on hunger incidence shows that the average hunger incidence from 2001 to 2009 (Arroyo administration) is 14.12 percent. Moreover, the average hunger incidence during this period increased by almost 8 percentage points, from 11.4 percent in 2001 to 19.2 percent in 2009. What is noticeable is that the trend of hunger incidence shifted and increased beginning the third quarter of 2003. In other words, the proportion of hunger incidence rapidly increased starting the 3<sup>rd</sup> quarter 2003 up to the 4<sup>th</sup> quarter of 2009, compared to the period before 2003. The data from the official statistics on hunger incidence (subsistence poor from NSCB), as well as other measures of hunger incidence from the FNRI and SWS, consistently show the same results: that hunger has worsened in the past years.

This paper examines the dynamic patterns of hunger incidence and the effects of the determinants of hunger using the quarterly time series data from the SWS national surveys on hunger. A vector autoregressive (VAR) model is used to analyze the impact of shocks on food prices and underemployment on the current and future hunger incidence. An important feature of this paper is the mainstreaming of the time series data on hunger incidence from the SWS into the econometric model through the VAR models. The organization of the paper is as follows: this section serves as the introduction, section 2 discusses the different methods of measuring hunger incidence in the Philippines as well as some of the government programs aimed at mitigating hunger incidence, section 3 discusses the trends in hunger incidence using the official statistics and the results from the self-rated hunger surveys, section 4 presents the results of the vector autoregressive (VAR) model for hunger incidence and section 5 concludes.

## 2. Measures of Hunger Incidence and Accelerated Hunger-Mitigation Program

### 2.1. National measures of hunger

Hunger is a complex phenomenon and a multi-dimensional concept. In the Philippines, there are several existing measures of hunger incidence. At the national level, Maligalig (2008) identifies four different measures of hunger: (1) the prevalence of food poor (or subsistence poor) computed by the National Statistical Coordination Board (NSCB); (2) the self-rated hunger incidence collected by the Social Weather Stations (SWS); (3) the hunger incidence compiled by the Bureau of Agricultural Statistics (BAS); and (4) the food security measures compiled by the Food and Nutrition Research Institute (FNRI).<sup>4</sup> The NSCB statistics on subsistence poor, measured from the Family Income and Expenditure Survey (FIES), and available every three years are also the official statistics on hunger in the country. The SWS, FNRI and the BAS measures of hunger incidence are referred to as the direct measures since these “were compiled on the basis of responses of individuals to questions about their experiences about hunger,” while the proportion of subsistence poor is an indirect measure of hunger (Maligalig, 2008).

In addition to these four measures, Salud-Payuno (2009) cited other indicators of hunger incidence that are regularly reported by government agencies such as the percentage of pre-schoolers below six years old who are undernourished based on the annual survey collected by the National Nutrition Council (NNC), the percentage of underweight children between 0 to 5 year-olds and prevalence of thinness among 0 to 5 year-olds from the National Nutrition Survey of the FNRI and the hunger index developed by the NSCB.<sup>5</sup>

#### 2.1.1. *National Statistical Coordination Board (NSCB) measure of subsistence incidence*

The official statistics on hunger incidence is the subsistence incidence or popularly called the food poor. The prevalence of subsistence poor refers to the proportion of families or individuals with per capita income/expenditure less than the per capita food threshold to the total number of families/individuals. The food threshold is determined using regional one-day menus priced at the provincial level. These menus are determined using low-cost nutritionally adequate food items satisfying basic food requirements of 2,000 calories which are 100% adequate for the recommended energy and nutrient intake (RENI) for energy and protein and 80% adequate for the RENI for vitamins, minerals and other nutrients (NSCB, 2010). The official statistics on subsistence incidence is determined using the food threshold and the income distribution derived from the Family Income and Expenditure Survey (FIES).

### 2.1.2 *Food and Nutrition Research Institute (FNRI) measure of food insecurity*

The Food and Nutrition Research Institute (FNRI), an agency affiliated with the Department of Science and Technology (DOST), conducts the National Nutrition Survey (NNS) to update the official statistics on the Philippines' food, nutrition and health situation (FNRI, 2010). The 2008 NNS is the seventh in a series of surveys undertaken by the FNRI every five years. The FNRI measure of hunger uses the Radimer-Cornell measures of food insecurity based on a set of 10 questions designed to evaluate food insecurity, adult's hunger and children's hunger.<sup>6</sup> In addition to the food insecurity measures, the NNS also provides information on the proportion of underweight and under height children, among other statistics.

### 2.1.3 *Social Weather Stations (SWS) measure of hunger indicator*

One criticism of the official statistics for measuring poverty and hunger incidence (from NSCB and FNRI) is that "being infrequently applied, (it) has fostered an illusion that poverty steadily declines" (Mahangas, 2009). On the one hand, the FIES is conducted only once every three years and the official hunger and poverty incidence statistics were reported only eight times from 1985 to 2006. The poverty and hunger incidence statistics from the 2009 FIES will only be released in 2011. On the other hand, the FNRI-NNS is conducted once every five years, the latest being the 2008 survey. If we are interested in measuring the impact of the recent global financial crisis on hunger and poverty incidence in the country, we will have to wait for NSCB's results in 2011 or FNRI's results in 2013. Due to the lack of a frequent measure of hunger incidence (and also poverty incidence) in the country, government officials depend on the national quarterly surveys on hunger conducted by the Social Weather Stations (SWS), particularly during periods between the FIES years.<sup>7</sup> The SWS is a private, non-profit scientific institute established in 1985 to generate social survey data. The SWS hunger indicator is defined as the proportion of household heads reporting that their families have experienced hunger, without having anything to eat, at least once in the last three months (Mangahas, 2009). The SWS quarterly survey has 1,200 respondents from various parts of the country. The respondents are asked if they have experienced hunger in the past three months. If the respondent answers yes, a second question is then asked regarding the frequency of the experience. The SWS further classifies hunger into moderate if it happened "only once" or "a few times" and severe if it happened "often" or "always."<sup>8</sup> The SWS quarterly hunger indicator is reported beginning July 1998 and covers 46 quarters up to December 2009. Maligalig (2008), however, pointed out that the SWS hunger incidence figures may underestimate the true values because of potential sources of bias due to its design components. She argues that while the sampling error for all estimates from the quarterly survey is about 2.83 percent, non-sampling

error due to potential problems with the sampling frame and sampling strategy can increase the over-all sampling and non-sampling error.<sup>9</sup>

## 2.2. Accelerated Hunger-Mitigation Program (AHMP)

To address the problem of hunger in the medium and long term, the administration of President Gloria Macapagal-Arroyo (GMA) initiated the Accelerated Hunger Mitigation Program, a strategy under the Medium Term Philippine Development Plan (MTPDP) of 2004-2010. The AHMP aims to address the causes of hunger, poverty, unavailability of food to eat, and a large family size. The AHMP aims for a holistic approach in addressing the problem of hunger and intervenes in both the supply side and the demand side.

On the supply side, the Department of Agriculture (DA), the Department of Health (DOH) and the Department of Social Work and Development (DSWD) take measures to produce more food and efficiently deliver this to those who need it. Some examples of these interventions are: (a) the Food for School Program of the DOH where a daily ration of one kilo of rice is provided for the families of grade 1, pre-school and day care centre children; (b) the *Tindahan Natin* (our store) Project of the National Food Authority (an attached agency of the DA) and the DSWD. A poor family can buy low-priced but good quality rice and noodles at the “*tindahan*”; (c) The *Gulayan ng Masa* (backyard gardening) and the Barangay Food Terminal programs of the DA which aim to provide alternative food sources. On the demand side, the AHMP aims to hire workers from poor areas to clean and maintain the country’s roads and highways under the emergency public work and food for work programs of the Department of Public Works and Highways (DEVPULSE-NEDA, 2007). The National Nutrition Council, an agency affiliated with the DOH is given the oversight function to ensure the implementation of the programs and projects within the AHMP framework (NNC, 2010).

Perhaps the most successful government intervention program in terms of mitigating hunger is the Pantawid Pamilyang Pilipino Programs or 4Ps. The 4Ps is a poverty reduction and social development strategy of the national government that provides conditional cash grants to extremely poor households to improve the health, nutrition and education, particularly of children aged 0-14. The households were selected from the poorest provinces, cities and municipalities based on the 2006 Family Income and Expenditure Survey (FIES) and 2003 Small Area Estimates (SAE) of NSCB, respectively. The poorest households in the municipalities are identified through a Proxy-Means Test that determines the socio-economic variables such as asset ownership, type of housing, education of the household head, livelihood of the family and access to water and sanitation. A household-beneficiary with three children whose ages range from 0 to 14 years can receive a maximum of P1,400 per month (about US\$30 at US\$1= P46 exchange rate) or P15,000 per year (about

US\$326) as long as they comply with the conditions related to the family’s health and education. These conditions state that pregnant women must avail of pre- and post-natal care and be attended during childbirth by skilled attendant, that parents must attend responsible parenthood sessions (for family planning), that children aged 0 to 5 years old must receive regular preventive check-ups and vaccines, that children aged 3 to 5 years old must attend day care or pre-school classes at least 85 percent of the time and that children aged 6 to 14 years old must be enrolled in elementary and high school at least 85 percent of the time and receive de-worming pills twice a year (DSWD, 2010). As of June 2009, the 4Ps covered about 700,000 households from 255 municipalities and 15 cities in 45 provinces, out of the total of 80 provinces. Some economists, notably Balisacan (2009), point out that the 4Ps with an allotted budget of about P10 billion per year for the 700,000 families is a more efficient program for poverty alleviation compared to the expensive Comprehensive Agrarian Reform Program (CARP) which cost the government about P237 billion (in 1997 prices) to implement.

### 3. Trends in Hunger Incidence

Official hunger statistics from the NSCB, shown in Table 1, indicate that while the percentage of subsistence poor among households have decreased from 8.2 percent in 2003 to 7.9 percent in 2009, the number of families that are considered subsistence poor actually increased from about 1.36 million to 1.45 million during the same period, largely due to a higher population. Moreover, the figures from the same table show the actual number of subsistence poor households increased in the three major geographical areas, in Luzon (about 31,000 families), Visayas (about 29,000) and Mindanao (about 36,000) in the same period.

**Table 1. Subsistence Incidence and Magnitude of Poor among Families**

Major Island Group	Poverty Incidence among Families (%)			Magnitude of Poor Families		
	2003	2006	2009	2003	2006	2009
PHILIPPINES	8.2	8.7	7.9	1,357,833	1,511,579	1,453,843
Luzon	4.4	5.1	4.3	418,439	506,974	449,388
Visayas	12.1	12.6	11.4	392,854	439,348	421,494
Mindanao	14.5	14.1	13.8	546,540	565,257	582,961

*Source: National Statistical Coordination Board (NSCB)*

Subsistence incidence among the population follows the same trend. The numbers in Table 2 shows that while the percentage of Filipinos experiencing hunger almost remained the same, decreasing only slightly from 11.1 percent in 2003 to 10.8 percent in 2009, the number of Filipinos experiencing hunger increased to 9.44 million in 2009 from 8.80 million in 2003. Furthermore, hunger incidence in Mindanao rose by about 264,000, to 3.71 million in 2009 from 3.44 million in 2003. It is clear that hunger incidence has worsened in Mindanao.

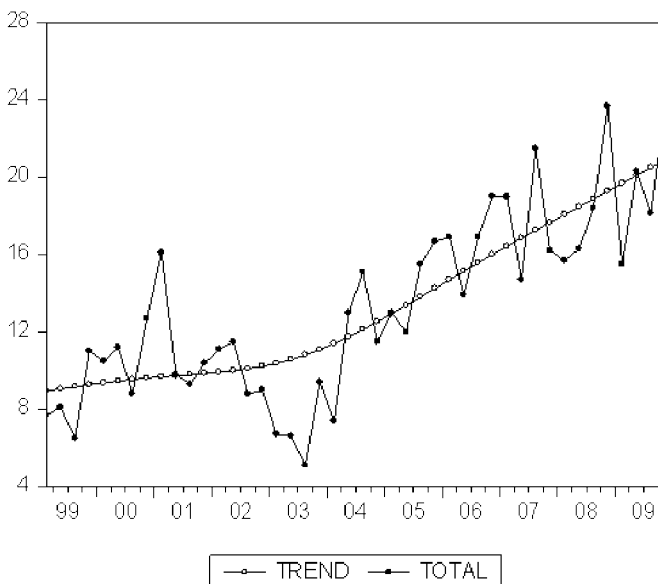
**Table 2. Subsistence Incidence and Magnitude of Poor among the Population**

Major Island Group	Subsistence Incidence among Population (%)			Magnitude of Poor Population		
	2003	2006	2009	2003	2006	2009
PHILIPPINES	11.1	11.7	10.8	8,802,918	9,851,362	9,440,397
Luzon	6.2	7.2	6.1	2,818,041	3,437,824	3,033,052
Visayas	16.2	16.8	15.3	2,540,826	2,806,891	2,699,031
Mindanao	18.7	18.2	18.2	3,444,051	3,606,647	3,708,314

Source: National Statistical Coordination Board (NSCB)

The time plot of the percentage of families experiencing hunger from the 1st quarter of 1999 to the 4th quarter of 2009 is shown in Figure 1 below, together with the estimate of the long-term trend of the percentage of hunger incidence computed using the Hodrick-Prescott (HP) filter.<sup>10</sup> The plot of the HP filter shows that the slope of the long-term trend component shifted during the 3rd quarter of 2003 and became steeper which indicates a relatively faster increase in the percentage of families that experienced hunger after the 3rd quarter of 2003 compared to the period before it.

**Figure 1 Percentage of Families Experiencing Hunger (TOTAL) and the Long Term Trend (Hodrick-Prescott) from First Quarter 1999 to Fourth Quarter 2009**



Source: Social Weather Stations (SWS) National Quarterly Surveys on Hunger and Authors' Computation of the Long Term Trend

#### 4. Vector AutoRegressive (VAR) Model for Hunger Incidence

This paper examines the dynamic patterns of hunger incidence and the effects of the determinants of hunger, food prices and underemployment rate. A vector autoregressive (VAR) model is used to analyze the impact of shocks on food prices, measured using the food component of the Consumer Price Index (CPI), and underemployment rate on the current and future hunger incidence.<sup>11</sup> The food group, composed of rice, corn, dairy products, eggs, fish, meat, food and vegetables, among others, represents 46.58 percent of total weight of the CPI measured in 2000 (NSO, 2010). This group has the largest weight in the index and any change in the prices of the food group will have an impact on the overall inflation rate.

Underemployment rate is the proportion of underemployed persons to the total population 15 years old and up. Underemployed persons include all employed persons who express the desire to have additional hours of work in their present job or an additional job, or to have a new job with longer working hours. Visibly underemployed persons are those who work for less than 40 hours during the reference period and want additional hours of work (NSO, 2010). The summary statistics of the variables used in this study are given in Table 3 below.

**Table 3. Summary Statistics for Hunger Incidence, Food Inflation and Underemployment Rate**

	Hunger Incidence	Food Component of the CPI	Food Inflation	Underemployment Rate
Mean	13.29	121.90	1.20	19.56
Median	12.85	116.55	1.10	19.50
Maximum	24.00	165.50	6.91	26.10
Minimum	5.10	98.10	(1.62)	15.30
Std. Dev.	4.76	20.87	1.37	2.73
Skewness	0.36	0.73	1.71	0.45
Kurtosis	2.39	2.35	8.72	2.59

##### 4.1 Augmented Dickey-Fuller (ADF) test

The time series on total hunger incidence, food component of the CPI and underemployment were tested for presence of unit roots using the Augmented Dickey-Fuller (ADF) test prior to building the VAR model. The results in Table 4 show that the time series hunger incidence and underemployment rates are stationary. However, the ADF test for the food component of the CPI showed that series has a unit root. The difference of the natural logarithm of the food component of the CPI was used in the VAR model.

**Table 4. Results of the Augmented Dickey-Fuller (ADF) Tests**

Variable	ADF test statistic	P-value	Conclusion
Underemployment	-3.913579	0.0042	Stationary
Total Hunger	-4.187364	0.0100	Stationary*
Food Inflation	2.825585	0.9985	Non-Stationary; I(1)

\* *Trend-Stationary series, the trend is deterministic*

## 4.2 Granger Causality test

One of the key questions that need to be addressed in regression is how useful some variables are for forecasting others. We need to investigate whether past values of a time series  $x_t$  can help forecast another series  $y_t$ . If it cannot, then we say that  $x_t$  does not Granger-cause  $y_t$ . The simplest and probably the best approach to test whether a particular observed series  $x_t$  Granger-causes  $y_t$  is through the use of the autoregressive (AR) specification. To implement this test, we assume a particular autoregressive lag  $p$  (usually selected using the AIC or SBC criterion) and estimate by OLS,

$$y_t = \alpha + \delta_1 y_{t-1} + \delta_2 y_{t-2} + \dots + \delta_p y_{t-p} + \beta_1 x_{t-1} + \dots + \beta_p x_{t-p} + \varepsilon_t$$

The results of the Granger causality tests show that Food Inflation *Granger Causes* Total Hunger Incidence at the 5 percent level of significance but not the reverse. Moreover, Underemployment also *Granger Causes* Total Hunger Incidence at the 10 percent level of significance but not the reverse.

**Table 5. Results of the Granger-Causality Test**

Null Hypothesis:	n	F-Statistic	P-Value *
Food Inflation does not Granger Cause Total Hunger	43	5.14096	0.0144 **
Total Hunger does not Granger Cause Food Inflation		1.00057	0.1616
Underemployment does not Granger Cause Total Hunger	43	2.81478	0.0506 ***
Total Hunger does not Granger Cause Underemployment		0.16594	0.3430
Underemployment does not Granger Cause Food Inflation	43	0.23455	0.3154
Food Inflation does not Granger Cause Underemployment		0.00583	0.4698

\* *one-sided p-value;*

\*\* *Food Inflation Granger Causes Total Hunger Incidence but not the reverse (at 5% level)*

\*\*\* *Underemployment Granger Causes Total Hunger Incidence but not the reverse (at 10% level)*

## 4.3 The VAR Model

The vector autoregressive (VAR) is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances (or shocks) on the system of variables. The main distinction of the VAR approach, compared to the other econometric models, is that it treats every endogenous variable in the system as a function of the lagged values of all endogenous variables in the system. When we are not confident that a variable is actually exogenous, we can

treat each variable symmetrically. In the three-variable case order one VAR (or VAR (1)) model we have,

$$\begin{aligned} y_t &= \beta_{10} - \beta_{12} z_t - \beta_{13} w_t + \gamma_{11} y_{t-1} + \gamma_{12} z_{t-1} + \gamma_{13} w_{t-1} + \varepsilon_{yt} \\ z_t &= \beta_{20} - \beta_{21} y_t - \beta_{23} w_t + \gamma_{21} y_{t-1} + \gamma_{22} z_{t-1} + \gamma_{23} w_{t-1} + \varepsilon_{zt} \\ w_t &= \beta_{30} - \beta_{31} y_t - \beta_{32} z_t + \gamma_{31} y_{t-1} + \gamma_{32} z_{t-1} + \gamma_{33} w_{t-1} + \varepsilon_{wt} \end{aligned} \quad (1)$$

where  $y_t$  is the total hunger incidence,  $z_t$  is the food inflation and  $w_t$  is the underemployment, all at quarter  $t$ . The  $\varepsilon_{yt}$ ,  $\varepsilon_{zt}$  and  $\varepsilon_{wt}$  are white noise disturbance terms with means 0 and standard deviations  $\sigma_y$ ,  $\sigma_z$  and  $\sigma_w$ , respectively. The equations in (1) are called the structural equations of the VAR. The parameters,  $\beta_{12}$ ,  $\beta_{13}$ ,  $\beta_{21}$ ,  $\beta_{23}$ ,  $\beta_{31}$  and  $\beta_{32}$  measure the contemporaneous effects while the  $\gamma$ 's measure the lag 1 effects. The equations are not in reduced form since, for example,  $y_t$  has contemporaneous effect on  $z_t$  and  $w_t$ .

Isolating the time  $t$  variables on the left-hand side, we have,

$$\begin{aligned} y_t + \beta_{12} z_t + \beta_{13} w_t &= \beta_{10} + \gamma_{11} y_{t-1} + \gamma_{12} z_{t-1} + \gamma_{13} w_{t-1} + \varepsilon_{yt} \\ \beta_{21} y_t + z_t + \beta_{23} w_t &= \beta_{20} + \gamma_{21} y_{t-1} + \gamma_{22} z_{t-1} + \gamma_{23} w_{t-1} + \varepsilon_{zt} \\ \beta_{31} y_t + \beta_{32} z_t + w_t &= \beta_{30} + \gamma_{31} y_{t-1} + \gamma_{32} z_{t-1} + \gamma_{33} w_{t-1} + \varepsilon_{wt} \end{aligned} \quad (2)$$

In matrix form,

$$\begin{bmatrix} 1 & \beta_{12} & \beta_{13} \\ \beta_{21} & 1 & \beta_{23} \\ \beta_{31} & \beta_{32} & 1 \end{bmatrix} \begin{bmatrix} y_t \\ z_t \\ w_t \end{bmatrix} = \begin{bmatrix} \beta_{10} \\ \beta_{20} \\ \beta_{30} \end{bmatrix} + \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \\ w_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \\ \varepsilon_{wt} \end{bmatrix}$$

Simplifying, we have,

$$\begin{aligned} B \underline{x}_t &= \Gamma_0 + \Gamma_1 \underline{x}_{t-1} + \underline{\varepsilon}_t \\ \underline{x}_t &= B^{-1} \Gamma_0 + B^{-1} \Gamma_1 \underline{x}_{t-1} + B^{-1} \underline{\varepsilon}_t \\ \underline{x}_t &= A_0 + A_1 \underline{x}_{t-1} + \underline{e}_t \end{aligned} \quad (3)$$

where

$$\underline{x}_t = \begin{bmatrix} y_t \\ z_t \\ w_t \end{bmatrix}, B = \begin{bmatrix} 1 & \beta_{12} & \beta_{13} \\ \beta_{21} & 1 & \beta_{23} \\ \beta_{31} & \beta_{32} & 1 \end{bmatrix}, \Gamma_0 = \begin{bmatrix} \beta_{10} \\ \beta_{20} \\ \beta_{30} \end{bmatrix}, \Gamma_1 = \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} \end{bmatrix}, \underline{\varepsilon}_t = \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \\ \varepsilon_{wt} \end{bmatrix}$$

The equations in (3) are called the reduced-form representation of a VAR (1) model. We can generalize the mathematical representation of the reduced-form VAR model as,

$$\underline{x}_t = A_0 + A_1 \underline{x}_{t-1} + A_2 \underline{x}_{t-2} + \dots + A_p \underline{x}_{t-p} + \underline{e}_t \quad (4)$$

where  $\underline{x}_t$  is a  $(k \times 1)$  vector of endogenous variables,  $\underline{A}_1, \underline{A}_2, \dots, \underline{A}_p$  are matrices of coefficients to be estimated, and  $\underline{e}_t$  is a  $(k \times 1)$  vector of forecast errors that may be contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables. The error vector  $\underline{e}_t$  is assumed to be normally distributed with mean  $\underline{0}$  and covariance matrix  $\underline{\Sigma}$ . The order of the VAR model ( $p$ ) is determined using the information criteria (Akaike, Schwarz and the Hannan-Quinn).

The results of the VAR (1) model using the quarterly time series data on total hunger incidence, food inflation and underemployment are given in Table 6 below. The paper is interested in the first equation of the VAR where the dependent variable is total hunger incidence (under the column total hunger). The total hunger incidence at quarter  $t$  can be explained significantly by the lag 1 values of total hunger incidence, food inflation and underemployment. Lag 1 values of total hunger incidence and food inflation are significant at 1 percent level while lag 1 value of underemployment is significant at the 10 percent level.

While the VAR model in Table 6 can be used to forecast the future hunger incidence, the estimated parameters are not that useful in analyzing the dynamic relationships of food inflation and underemployment on total hunger incidence since the errors in equation (4) are not the original structural errors but the forecast errors. The dynamic relationship of the VAR model is derived using the Impulse Response Function (IRF).

**Table 6. VAR (1) model Total Hunger Incidence, Food Inflation and Underemployment**

	Total Hunger	Food Inflation	Underemployment
Total Hunger (lag 1)	0.69 (0.11) [6.50]	0.05 (0.05) [1.08]	0.04 (0.09) [0.40]
Food Inflation (lag 1)	0.83 (0.34) [2.42]	0.34 (0.15) [2.31]	(0.00) (0.29) [-0.02]
Underemployment (lag 1)	0.32 (0.17) [1.88]	(0.05) (0.07) [-0.64]	0.46 (0.14) [3.25]
Constant	(2.75) (3.41) [-0.81]	1.04 (1.48) [0.70]	10.08 (2.86) [3.53]
R-squared	0.63	0.18	0.23
Adj. R-squared	0.60	0.11	0.17
Akaike Info. Criterion*	5.12	3.44	4.76
Schwarz Info. Criterion*	5.28	3.61	4.92

Standard errors are in ( ) and t-statistics in [ ];

\* lag 1 is selected as the appropriate lag order using the AIC and SIC

#### 4.4 Impulse Response Function (IRF)

A shock to the  $i^{\text{th}}$  variable (e.g. increase in food prices or underemployment rate) not only directly affects the  $i^{\text{th}}$  variable but is also transmitted to all the other endogenous variables, in particular total hunger incidence, through the dynamic (lag) structure of the VAR. An impulse response function traces the effect of a one-time shock to one of the innovations (error terms) on the current and future values of the endogenous variables. If the error terms are contemporaneously uncorrelated, then the  $i^{\text{th}}$  innovation ( $\epsilon_{it}$ ) is simply a shock to  $y_{it}$  or what is referred to as “shock to itself.”

#### 4.5 Response of total hunger to a shock in food inflation

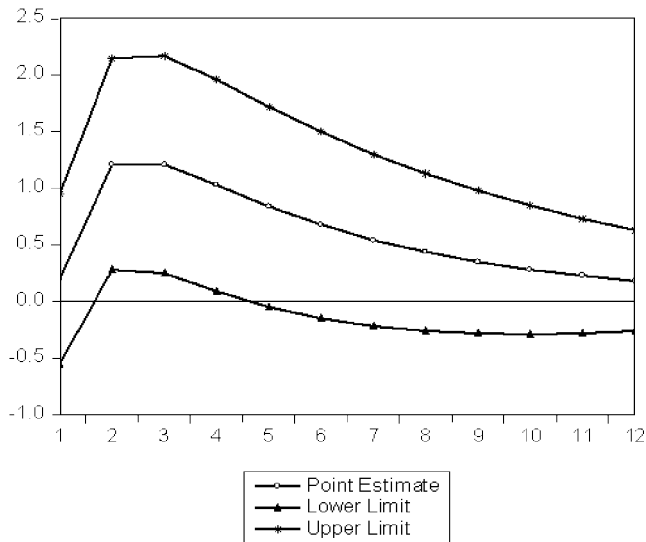
The response of total hunger to a shock in food prices is given in Table 7 below. The IRF shows that a one-time shock (or increase) to food prices at quarter  $t$  will have a significant effect on total hunger for the succeeding five periods, starting at quarters  $(t + 1)$  and ending at quarter  $(t + 5)$ . The effect of a shock to food prices is significant in increasing total hunger incidence at the 5% level for the first 3 quarters and significant at the 10% level for the last two quarters. After quarter  $(t + 5)$ , the effect of the shock to food prices on total hunger is no longer significantly different from zero (or the effect decays to zero) as shown in Figure 2. In particular, a one standard deviation increase to food inflation (about 1.37 percentage points) at quarter 1 will increase total hunger by about 1.21 standard deviation or 5.76 percentage points in the next quarter, all things being the same. The increases in the next four quarters are: 5.77 percentage points (in quarter 3), 4.90 percentage points (in quarter 4), 3.99 percentage points (in quarter 5) and 3.22 percentage points (in quarter 6). The numbers mean that total hunger incidence is very sensitive to changes in food prices, a spike in food inflation equivalent to say one percentage point at the current quarter will increase hunger incidence by 4.21 percentage points in the next quarter or an additional 772,000 households that will experience hunger.

**Table 7. Impulse Response Function – Response of Total Hunger Incidence to a one standard deviation increase in Food Inflation at Quarter 1**

Quarter	Impact of an Increase in Inflation to Total Hunger	t-stat
1	0.20	0.44
2 *	1.21	2.13
3 *	1.21	2.08
4 *	1.03	1.81
5 **	0.84	1.56
6 **	0.68	1.35
7	0.54	1.17
8	0.44	1.03
9	0.35	0.91
10	0.28	0.82
11	0.23	0.74
12	0.18	0.67

\* significant at the 5 percent level; \*\* significant at the 10% level (one-sided alternative)  
Cholesky Ordering: Food Inflation, Underemployment, Total Hunger

**Figure 2. Increase in Hunger Incidence from Quarter 1 to Quarter 12 Resulting from One Standard Deviation Increase in Food Prices at Quarter 1**



#### 4.6 Response of total hunger to a shock in underemployment

While the one-time shock to food prices affects total hunger for a period of five quarters, the IRF results in Table 8 show that a one-time increase in underemployment rate at quarter  $t$  will have significant effects on total hunger for the succeeding two quarters: quarters  $(t + 1)$  and  $(t + 2)$ . Moreover, the effect of an increase in underemployment rate to total hunger is significant only at the 10% level. A one-standard deviation increase in underemployment rate, equivalent to about 2.37 percentage points at quarter 1 will increase total hunger incidence by about 0.76 standard deviation or 3.63 percentage points in the next quarter (quarter 2), all things being the same. The increase in quarter 3 is about 0.79 standard deviation or 3.76 percentage points. After quarter 3, the impact of one-time increase in underemployment rate is no longer significant. An increase in underemployment rate of one percentage point at the current quarter will increase hunger incidence by 1.33 percentage points in the next quarter or an additional 244,000 households that will experience hunger.

The good news is that underemployment rate in April 2010 at 17.8 percent is lower compared to that of April 2009 at 18.9 percent and also lower than the average underemployment rate of 19.56 percent from the 1<sup>st</sup> quarter of 1999 to the 4<sup>th</sup> quarter of 2009 (although the unemployment rate spiked up to 8 percent in the same quarter).

Moreover, of the 414,000 new jobs created from April 2009 to April 2010, about 210,000 of these came from the manufacturing sector. The bad news is that a significant number of new jobs created are still in the informal sector, such as trade-related jobs, and the government-created emergency jobs mainly as a response to the global financial crisis.

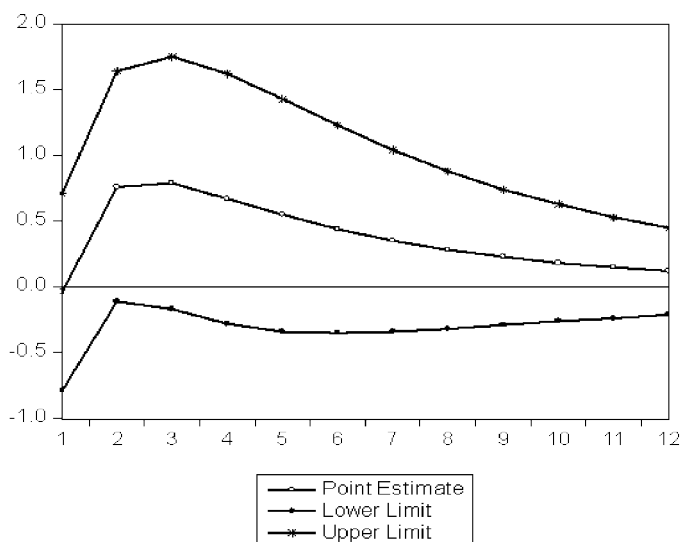
**Table 8. Impulse Response Function – Response of Total Hunger Incidence to a One Standard Deviation Increase in Underemployment at Quarter 1**

Quarter	Impact of an Increase in Inflation to Total Hunger	t-stat
1	-0.04	-0.09
2 **	0.76	1.43
3 **	0.79	1.36
4	0.67	1.16
5	0.55	1.02
6	0.44	0.92
7	0.35	0.84
8	0.28	0.78
9	0.23	0.72
10	0.18	0.67
11	0.15	0.63
12	0.12	0.59

*\*\* significant at the 10% level (one-sided alternative)*

*Cholesky Ordering: Food Inflation, Underemployment, Total Hunger*

**Figure 3 Increase in Hunger Incidence from Quarter 1 to Quarter 12 resulting from One Standard Deviation Increase in Underemployment Rate at Quarter 1**



## 4.7 Forecast error variance decomposition

While the impulse response functions trace the effects of a shock to one endogenous variable on the other variables in the VAR model, the Forecast Error Variance Decomposition tells us the proportion of the movements in the series (e.g. total hunger) due to its “own” shocks versus the shocks to the other variables (food inflation and underemployment). In applied research it is typical for a variable to explain almost all of its forecast error variance at short horizons and smaller proportions at longer horizons. The variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR model. The forecast error variance decomposition of total hunger given in Table 9 below shows how much of the future error variance of total hunger can be explained by shocks to total hunger, food inflation and underemployment. The results show that shock to total hunger (or “own shock”) can explain almost all, 99.53 percent, of the variance of the forecast error of total hunger at quarter  $(t + 1)$ . The shocks to food inflation and underemployment have negligible effect to the forecast error variance of total hunger at the next quarter. However, at quarter  $(t + 2)$ , about 14 percent of the forecast error variance of total hunger can now be explained by shocks to food inflation and underemployment. At quarter  $(t + 3)$ , the total variance explained by food inflation and underemployment increased to about 21 percent. This value stabilizes at around 28 percent which implies that shocks to food inflation and underemployment explain about 28 percent of the future forecast error variance of total hunger, making these two variables important determinants of total hunger.

**Table 9. Forecast Error Variance Decomposition of Total Hunger**

Period	S.E.	Total Hunger	Food Inflation	Underemployment
1	2.988684	99.53245 (4.44744)	0.446861 (3.36775)	0.020694 (2.72259)
2	3.898978	86.25213 (10.6173)	9.909387 (9.50938)	3.838486 (5.48614)
3	4.445916	78.83321 (13.1000)	15.06570 (12.2656)	6.101084 (8.47213)
4	4.777240	75.05440 (14.2422)	17.68829 (13.7084)	7.257312 (10.4050)
5	4.981098	73.01823 (14.8482)	19.10478 (14.5297)	7.876993 (11.6201)
6	5.108408	71.85578 (15.2368)	19.91541 (15.0431)	8.228810 (12.4095)

## 5. Conclusions

This paper examines the dynamic patterns of hunger incidence in the Philippines using the quarterly survey data on hunger from the Social Weather Stations (SWS). The results of the econometric model based on the vector autoregressive (VAR) show that food inflation and underemployment are important determinants of hunger incidence in the Philippines. A one-time increase in food prices can lead to increases in hunger incidence that will last for five quarters, while a one-time increase in underemployment will lead to increases in hunger incidence for two quarters. An important contribution of this paper is the mainstreaming of the time series data on hunger incidence from the SWS into the econometric model through the VAR models. The results of the study are useful in crafting policies and programs that could help alleviate hunger in the country. For one, hunger incidence is very sensitive to changing food prices and thus the supply side strategies of the AHMP such as increasing food production and enhancing the efficiency of logistics and food delivery must be improved. Take for example the case of the *Tindahan Natin* (TN) stores that sells low-priced but quality goods. The SWS survey in June 2006 (no available data on access after this period) shows that only 6.6 percent of households said that there is a TN outlet in their locality and only 3.0 percent actually bought something from these outlets. Clearly, only a small percentage of the poor households have been reached by this program. Increasing the number of TN stores to increase the number of poor households that can access these outlets should be a priority of the DSWD.

However, Manasan and Cuenca (2007)<sup>12</sup> found that the two major programs under the hunger mitigation initiative of the Arroyo administration, namely: *Tindahan Natin* Program and Food-for-School Program, suffer from poor targeting. Exclusion and leakage rates are considerably high. Thus, in addition to increasing the number of TN stores, targeting system of the TN, as well as the FSP, program should be revisited.

In the case of the underemployment, increasing the number of new jobs that will be created and enhancing the quality of jobs are important factors that will decrease the hunger incidence in the country. Priorities should be made in the area of improving the investment climate for investors through stable and predictable government policies as well as battling corruption and red tape in government transactions.

The paper shows that hunger incidence is very dynamic and frequent monitoring, for example, quarterly, of hunger incidence through self-rated surveys, perhaps at the provincial level, is important in order to monitor and assess the effectiveness of the government programs (e.g. *Tindahan Natin*, Conditional Cash Transfer, Food for School, Comprehensive Livelihood and Emergency Employment Program) in mitigating hunger. These self-rated surveys can complement the official statistics on hunger incidence computed by the NSCB every three years from the FIES.

Finally, policies that address the hunger incidence in the country must include measures that will manage the country's burgeoning population and bring down the fertility rate to a manageable level. Millions of Filipinos go through the vicious cycle of high fertility and poverty and hunger: a high fertility rate prolongs poverty/hunger in households and poor households contribute to high fertility rates. Policy makers must address the country's rapid population growth head-on through proactive government policies.

## Notes

- 1 Earlier version of this paper was presented at the Millennium Development Goals (MDG) Forum organized by the National Academy of Science and Technology (NAST) last February 2, 2010 at Trader's Hotel in Manila and at the Annual Seminar Series on Food Security and Sustainable Development organized by the Institute of Statistics (INSTAT) and the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), University of the Philippines in Los Baños. The authors are grateful to the participants, particularly Dr. Arsenio M. Balisacan, Dr. Mahar Mangahas, Dr. Romulo A. Virola, for their comments and suggestions. The authors are also grateful to Administrator Carmelita N. Ericta of the National Statistics Office (NSO) and Ms. Rosie Sta. Ana, Chief of the Economic Indices and Indicators Division of the NSO, for providing us with the time series data on the Food Component of the Consumer Price Index, to Dr. Mahar Mangahas of the SWS for sharing the time series data on hunger incidence and to Dr. Jocelyn Juguan of the Food and Nutrition Research Institute (FNRI) for sharing the highlights of the 7th National Nutrition Survey (NNS). The authors would like to thank two anonymous referees for their helpful comments and suggestions. All errors are the authors' responsibility.
- 2 The average growth rate of the Gross Domestic Product (GDP) in constant prices from 2001 to 2009 is about 4.5 percent and with population growing at an average rate of 2.04 percent per year, the per capita GDP growth is only between 2.4 to 2.5 percent, a modest rate by East Asian standard.
- 3 The annual population growth from 2000 to 2007 is 2.04% based on the results of the 2007 Census of Population. In August 2007, the population of the Philippines is 88.57 million.
- 4 The Survey of Hunger Incidence in the Philippines (SHIP) was conducted by the Bureau of Agricultural Statistics (BAS), a service agency of the Department of Agriculture (DA) in August 2006. The SHIP covered more than 13,000 household-respondents. The SHIP used the same questions asked in the SWS quarterly survey. Unfortunately, no follow-up survey was made after 2006 and the results from the SHIP are not amenable for comparison across time.

- 5 Salud-Payumo (2009) also discussed the four measures discussed by Maligalig (2008) and referred to the NSCB measure of hunger incidence as the quantitative measure while the hunger measures from the SWS, BAS and FNRI as the qualitative measures. The NSCB's hunger index is measured as the average of three indicators: (a) the proportion of households with per capita energy consumption less than the requirement; (b) proportion of underweight children under 5 years and; (c) mortality rate of children under 5 years.
- 6 The 10 questions used are discussed in Maligalig (2008), pp. 120-121.
- 7 Government agencies involved in the Anti-Hunger Mitigation programs (AHMP), such as the Department of Social Work and Services (DSWD), National Nutrition Council (NNC) and the National Economic and Development Authority (NEDA) make use of the SWS hunger incidence indicator to gauge the effectiveness of the strategies.
- 8 While the SWS hunger indicator reports the total hunger incidence as well as the moderate and severe hunger incidence, this paper focus only on the total hunger incidence for its analysis.
- 9 The readers are referred to Maligalig's 2008 paper "Examining the Existing Direct Measures of Hunger in the Philippines" for an extensive discussion on the sampling and estimation issues. When one would like to measure the (partial) effect of a variable,  $X_t$ , but we can only observe an imperfect measure  $\tilde{X}_t$ , where  $\tilde{X}_t = X_t + w_t$ , one can show that the least squares estimator  $\hat{\beta}_1$  has probability limit  $\beta_{1z}(\sigma^2_x / (\sigma^2_x + \sigma^2_w))$  and is biased toward zero. However, if the error ( $w$ ) is constant, the variance,  $\sigma^2_w$  is zero and the estimator is still consistent.
- 10 The HP filter, first proposed by Hodrick and Prescott (1997) uses a smooting method to obtain an estimate of the long-term trend component of a time series. The HP filter computes the permanent component ( $TR_t$ ) of a time series  $y_t$  by minimizing the variance of  $y_t$  around  $TR_t$ , subject to a penalty that constrains the second difference of  $TR_t$ .
- 11 This paper uses underemployment rate as a measure of the quality of jobs, rather than unemployment rate.
- 12 PIDS Discussion Paper Series No. 2007-10 titled "Who benefits from the Food-for-School Program and Tindahan Natin Program: lessons in targeting"

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