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Understanding India's Food Inflation: The Role of Demand  
and Supply Factors

by Rahul Anand, Naresh Kumar, and Volodymyr Tulin

I N T E R N A T I O N A L M O N E T A R Y F U N D

## IMF Working Paper

Asia and Pacific Department

### Understanding India's Food Inflation: The Role of Demand and Supply Factors<sup>1</sup>

Prepared by **Rahul Anand, Naresh Kumar, and Volodymyr Tulin**

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#### Abstract

Over the past decade, India has seen a prolonged period of high inflation, to a large extent driven by persistently-high food inflation. This paper investigates the demand and supply factors behind the contribution of relative food inflation to headline CPI inflation. It concludes that in the absence of a stronger food supply growth response, food inflation may exceed non-food inflation by 2½–3 percentage points per year. The sustainability of a long-term inflation target of 4 percent under India's recently-adopted flexible inflation targeting framework will depend on enhancing food supply, agricultural market-based pricing, and reducing price distortions. A well-designed cereal buffer stock liquidation policy could also help mitigate food inflation volatility.

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## I. INTRODUCTION

Unlike in many advanced economies, food inflation has had a non-trivial impact on aggregate retail inflation in India (Anand and others, 2014; Walsh, 2011), reflecting several causes, notably:

- (i) High share of food expenditure in total household expenditure and correspondingly high weight in the CPI;
- (ii) Inflation expectations which are anchored by food inflation; and
- (iii) Wage indexation to consumer price inflation and thereby indirectly to food inflation.

The importance of these factors in shaping India's inflation dynamics and determining the conduct of monetary policy, particularly the presence of large second-round effects of food price shocks, has been documented previously (Anand et. al, 2014; RBI, 2014a). However, there is no consensus on the possible drivers of persistently-high food inflation in India. The relative importance of demand and supply factors and the role of related non-monetary policies— notably the role of minimum support prices (MSP) and Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA)—are still debated.

Gokarn (2011) in his comprehensive analysis of India's key food price issues since the 1960s concludes that when food prices rise while supply stagnates or fails to keep up, there is no alternative to curbing food inflation often than raising supply rapidly. Sonna et al (2014) provide additional evidence of the significance of demand forces driving India's food inflation, showing that rising real rural incomes to have had the largest impact on food inflation, with a relatively smaller impact of cost push factors. While many studies<sup>2</sup> have investigated demand and the supply of key food commodities in India and projected demand and supply scenarios, even at commodity level, analysis of food prices in an equilibrating demand-supply framework is practically non-existent.

The purpose of this paper is thus to explore the relative role of demand and supply factors and also to quantify their impact on the dynamics of food prices in India in a market equilibrium setting. To do so, we adopt a two-stage strategy. First, we estimate individual demand for major food product groups, accounting for key household consumption patterns, using Indian household expenditure surveys. Next, we construct a food market equilibrium model, which for given output growth scenarios, allows us to estimate the impact of demand side pressure on relative food prices. Using this model, we estimate the size of relative food prices in recent years as well as simulate possible scenarios of the contribution of relative food inflation in the medium term. With respect to scenario analysis, the approach of

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<sup>2</sup>See Ganesh-Kumar (2012) and Bhattacharya and others (2014) for a literature review, as well as for medium-term forecasts on India's demand and supply gaps for food grains.

abstracting away from explicit modeling of food supply is not without limitations<sup>3</sup>, and the estimated inflation outcomes are likely to have an upward bias. Nonetheless, as own price supply elasticities (Kumar and others, 2010) are found to be significantly below demand elasticities, effects on prices from shifts in demand are likely to be only minimally mitigated by the response of supply, particularly over the near term.

Our results suggest that given the large weight on food in household expenditure, robust real income growth in the recent decade has resulted in substantial demand-side pressures. As supply of key agricultural products did not keep pace with real personal consumption growth, growth in food prices has outpaced non-food prices by about 3½ percent since 2006/07. As real personal consumption growth is expected to be robust and supply to be relatively sluggish in the coming years, it seems that India's inflation dynamics will continue to be shaped by the trend in relative food prices.

Our estimates suggest that in the absence of a stronger food supply response, relative food inflation can contribute about 1¼ percentage points to headline CPI inflation annually. If private consumption growth picks up to 7 percent and supply growth response remains at its historical level, Indian food inflation is likely to exceed non-food inflation by 2½–3 percentage points per year. Therefore, monetary policy would need to react appropriately to both supply shocks as well as underlying inflation trends, particularly in the context of recently adopted flexible inflation targeting. Achieving India's long-term inflation target of 4 percent will hinge on enhancing food supply, market-based pricing of agricultural produce, and reducing price distortions. As well, our simulation analysis indicates that given India's supply-side vulnerabilities, the recommended inflation band of +/- 2 percent appears broadly appropriate. In addition, a well-designed cereal buffer stock liquidation policy could help mitigate inflation volatility, while administered price setting, such as through MSPs and supporting policies, will continue to pose challenges for monetary policy management in India. Finally, at the current juncture where relative food prices do not appear to be a key driver of headline inflation, ensuring a durable reduction in headline inflation will require continuation of the current relatively tight monetary stance to durably lower core inflation, and to sustainably reduce inflation expectations and anchor them at a lower level.

The paper is organized as follows. In Section II, we examine inflation dynamics in India and present some empirical facts to further motivate the analysis. In Section III, we present a Quadratic Almost Identical Demand System (QUAIDS) model tailored to study India's food inflation. Section IV describes the results of the estimation and discusses their policy implications. Section V concludes.

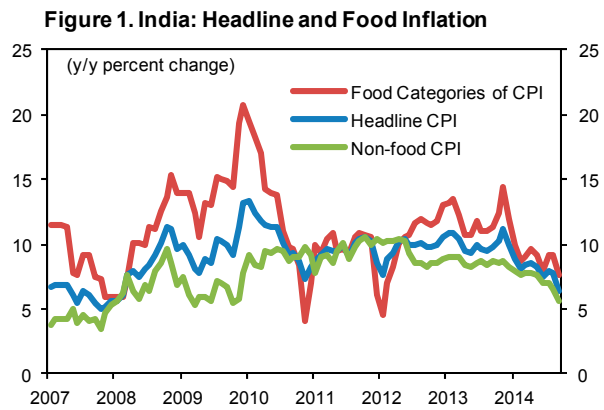
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<sup>3</sup> As in an inelastic supply system only price (but not supply) adjusts to equilibrate demand.

## II. BACKGROUND

### A. RECENT INFLATION DYNAMICS IN INDIA: SOME FACTS

High and persistent inflation has been a key macroeconomic challenge facing India (see IMF 2014a, 2014b, Anand et al, 2014). Elevated inflation coinciding with a growth slowdown distinguished India from other major emerging market economies in recent years. Though several reasons have been put forward to explain this persistently-high inflation in India, food inflation has been often singled out as a key driver. Indeed, food inflation has exceeded non-food inflation by about 3½ percentage points on average during 2006/07–2013/14, contributing directly about 1¾ percentage points to headline CPI inflation (Figure 1). Furthermore, through its second-round effects on core inflation (Anand et al, 2014), food inflation has added further to the inflationary pressure.



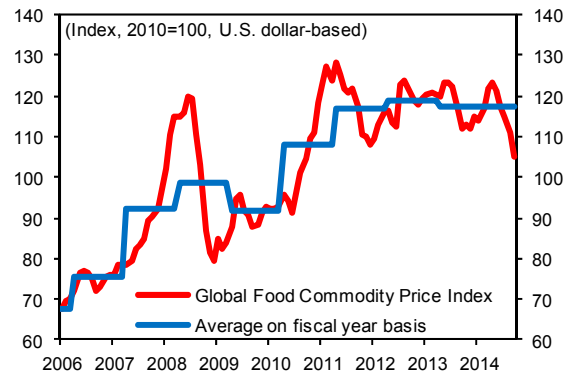
### B. INDIA'S FOOD INFLATION: THE TIMELINE

A chronological account of India's recent food inflation reveals several important events, many widely documented and researched (Gokarn, 2011; Thangzason and others, 2014):

- A set of policy interventions commonly known as the “Green Revolution” limited food inflation episodes to be short-lived and less intense during the 1980s and 1990s. Such interventions, that combined price incentives, input subsidies, technological inputs and infrastructure investments, (particularly in irrigation) and, very importantly, buffer stocks, helped to raise and stabilize the productivity of cereal cultivation, as well as other crops (Gokarn, 2011).
- However, during the 1990s and 2000s, agricultural supply growth slowed, averaging about 3½ percent per annum; while cereal production grew by only 1½ percent per annum in the 2000s. Against firming consumer demand, running down buffer stocks helped contain food inflation during the early 2000s, as MSP growth moderated (Figure 2).
- The Indian government's response to a surge in global food prices beginning in 2007-08, helped limit the impact on domestic food prices (OECD, 2009). However, buffer stocks continued to fall, eventually falling significantly below accepted norms. For example, around mid-2007, the wheat stock in the Central Pool amounted to only about half of the buffer stock norm. Moreover, a series of government measures – such as, large increases

in food and fertilizer subsidies, and over 30 percent increase in minimum support prices for the 2008/09 season – likely not only postponed but also prolonged inflationary pressures, even after global food commodity prices abated (Figure 3). In addition, the global commodity price spike episode of 2007–08 also led to excessive stock hoarding in the subsequent years, a shift in the buffer stock policy resulting in sustained inflationary pressure (Figure 2)<sup>4</sup>.

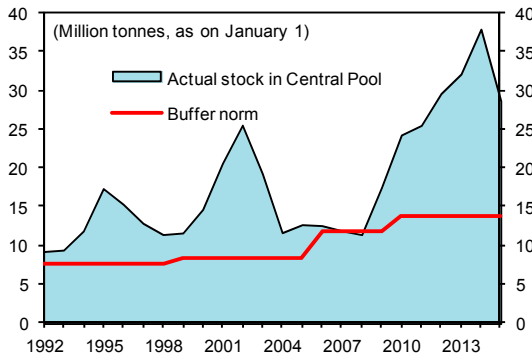
**Figure 3. Global Food Commodity Prices**



Source: International Financial Statistics.

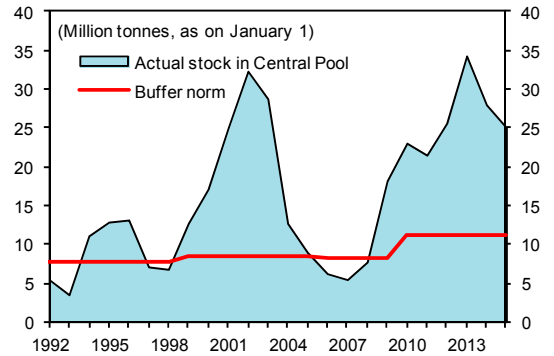
**Figure 2. Policy Interventions and Outcomes: Buffer Stocks of Rice and Wheat**

**Rice: Buffer Norms and Actual Stock in Central Pool**



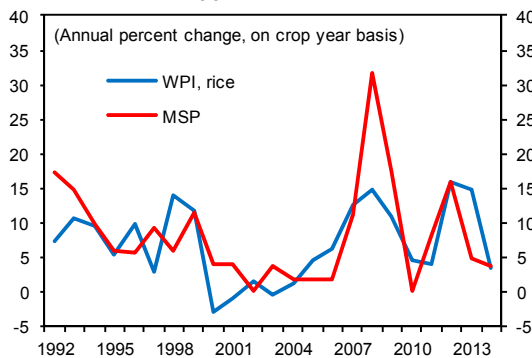
Sources: Food Corporation of India; and IMF staff calculations.

**Wheat: Buffer Norms and Actual Stock in Central Pool**



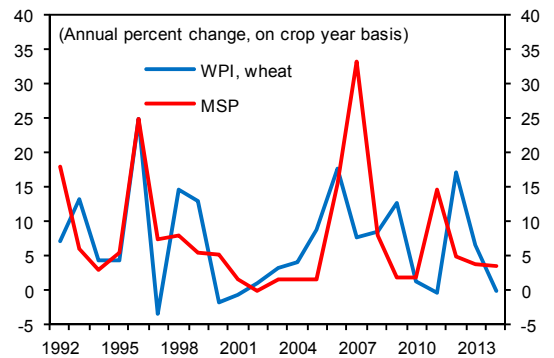
Sources: Food Corporation of India; and IMF staff calculations.

**Rice: Minimum Support and Actual Prices**



Sources: Food Corporation of India; and IMF staff calculations.  
Note: Crop year denotes a 12-month period from July through next June.

**Wheat: Minimum Support and Actual Prices**

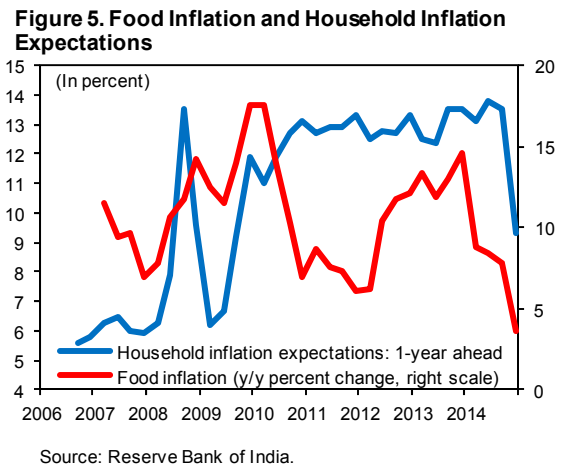
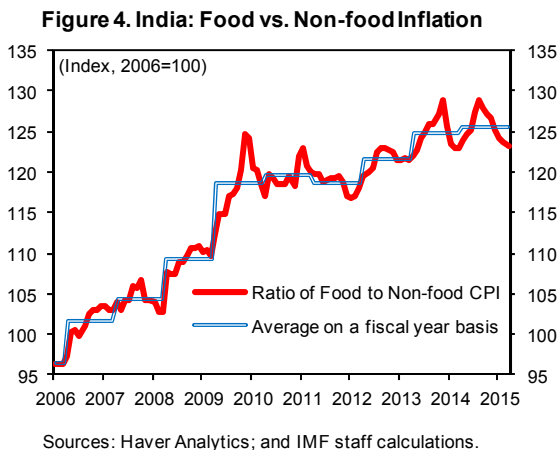


Sources: Food Corporation of India; and IMF staff calculations.  
Note: Crop year denotes a 12-month period from July through next June.

<sup>4</sup> In the aftermath of the 2007-08 surge in global commodity prices, not only food importers but also the largest exporters, namely China and India, became wary of over-reliance on international grain markets, particularly in times of food emergency, which led to a massive grain procurement and hoarding.



- Deficient rainfall, as a result of the weaker monsoon in 2009, affected output of key agricultural crops and was an important factor behind elevated food inflation spilling into 2010 (RBI, 2014b). Overall, growth in food inflation outpaced non-food inflation by almost 30 percentage points during 2006–10: food inflation exceeded non-food inflation on an average by almost 7½ percentage points per year during this period (Figure 4).
- Yet, even though 2010 turned out to be a good monsoon year, food inflation remained high. Furthermore, despite 2011 being another relatively good monsoon year, food inflation surged again following a minor blip in food prices. Moreover, this time non-food inflation also picked up simultaneously, averaging about 9½ percent during 2010–13 – a full 3 percentage points higher than the average of 6½ percent recorded during 2006–09.
- Thus, even as relative food prices staged only a moderate gain during 2010–14, headline inflation remained high, driven by entrenched, elevated inflation expectations, and firming of the inflationary spiral with food inflation feeding quickly into wages and core inflation (Figure 5).



### C. INDIA'S FOOD INFLATION: THE SUPPLY-DEMAND ANGLE

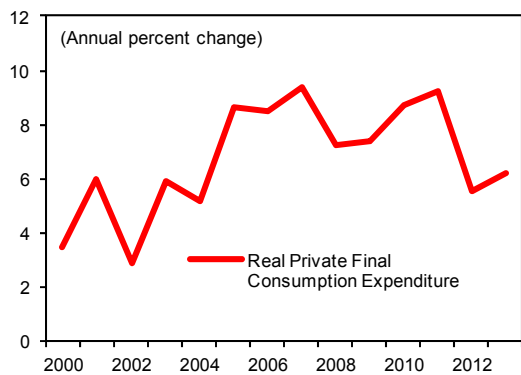
While a number of supply side-factors could be responsible for Indian food price pressures, they need to be scrutinized in the context of India's growing food demand.

Underpinned by robust economic growth, India's private consumption growth rose to about 8½ percent during 2005/06–2011/12, up from 5 percent average growth rate recorded during 1998/99–2004/05 (Figure 6). Moreover, private consumption growth was essentially unaffected by the Global Financial Crisis (GFC). However, following a slowdown in the economy, private consumption growth declined in 2012/13 and 2013/14; thereby, reducing demand-side pressures on food inflation.

Agricultural GDP growth remained robust during 2005/06–2007/08, growing at around 5 percent per year (Figure 7). However, with private consumption growing at 9 percent during these years, demand-side pressures – aggravated by a surge in global commodity prices – contributed significantly to the rise in relative food prices in India (Figure 4). During these three years, food inflation accelerated significantly. For example, WPI food inflation<sup>5</sup> jumped to about 8¾ percent per year during this period from about 1¾ percent average recorded during 2000/01–2004/05. Furthermore, the surge in relative food prices continued for another two years (2008/09–2009/10). Even though private consumption growth moderated due to the GFC, it remained strong during 2008/09–2009/10. Coupled with weak agricultural GDP growth in those years (due to deficient rainfall), it led to a further rise in relative food prices.

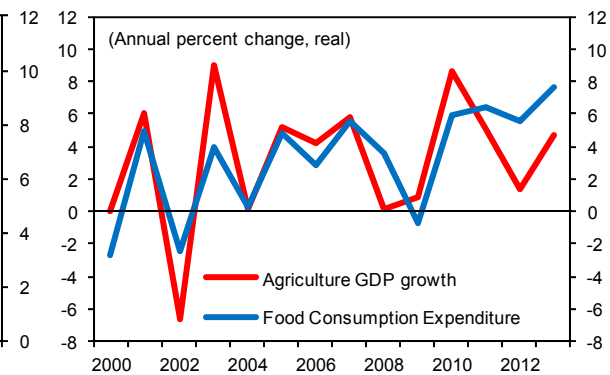
Finally, as a result of a good monsoon, agricultural GDP growth recovered in 2010/11 and 2011/12 to 8½ and 5 percent, respectively (Figure 7). Simultaneously, with a concurrent moderation in private consumption growth due to the economic slowdown, relative food prices remained broadly stable during 2010/11–2011/12. However, non-food inflation during this period was high and remained firm in the 9–10 percent range, partly as a result of the accommodative monetary stance in India resulting from a delayed withdrawal of stimulus provided during the GFC (Anand and Tulin, 2014, Mohan and Kapur, 2015).

**Figure 6. India: Private Consumption**



Sources: Haver Analytics; and IMF staff calculations.

**Figure 7. India: Supply and Demand for Food**



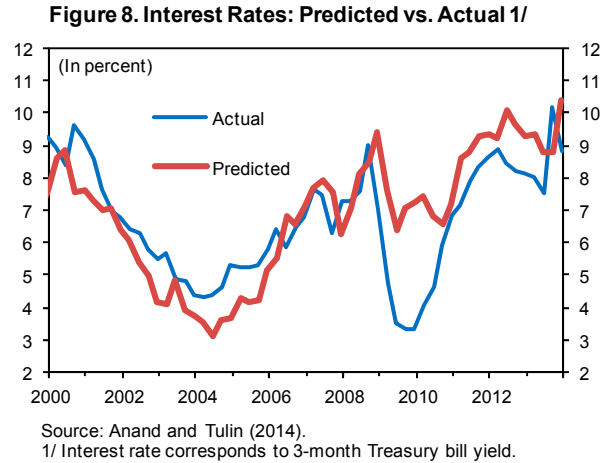
Sources: Haver Analytics; and IMF staff calculations.

#### **D. INDIA'S FOOD INFLATION: A RESULT OF LOOSE MONETARY POLICY**

While monetary policy in India was eased suitably to counter the effects of GFC, the subsequent tightening that began in 2010 was not sufficient to rein in inflation that had become generalized by then. As suggested by Anand et al (2014), the short-term interest rate

<sup>5</sup> WPI food inflation averaged slightly under 5 percent during 1994/95–2004/05 and about 9¾ percent during 2004/05–2013/14. WPI food inflation has been broadly in line with CPI food developments, while providing a longer series of a consistently defined gauge of aggregate food prices.

gap vis-à-vis its optimal level, a gauge of the monetary stance, averaged about 100 basis points during 2011–12 (Figure 8). Successive IMF India Staff Reports highlighted the role of too accommodative a monetary stance in fostering persistently high inflation, and argued for a tighter monetary stance to counter inflation and inflationary pressures (IMF, 2011b; and IMF 2012, 2013, 2014a, 2014b). Concerns over the insufficient tightening were also raised in India.<sup>6</sup>



### III. THE MODELING FRAMEWORK

To study the interaction of food demand and supply in determining food prices in India, we use a modeling framework to estimate the demand of key food item groups using India’s household surveys. Next, we turn to model the supply of these key food item groups and use a food market equilibrium framework to analyze the interaction of demand and supply in determining food prices in India.

As highlighted in the previous section, growing per capita income has translated into higher demand for food. Engel’s law states that as the average household income increases the average share of food expenditure in total expenditure declines. The Engel curve for food has been found to be log-linear and stable, both over time and across societies (Banks, Blundell, and Lewbel 1997; Beatty and Larsen 2005; Blundell, Duncan, and Pendakur 1998; Leser 1963; Yatchew 2003).

#### A. Household Demand Analysis

Our food demand modeling approach relies on a two-stage budgeting framework, which assumes that consumers allocate their income in two steps. In the first step, consumers decide on spending across broad categories of goods or services – in our model, it entails a choice between food and non-food. Each consumer decides on how much to spend on food items and how much to spend on non-food items. In the second step, each consumer

<sup>6</sup>As, for example, noted by Dr. Rangarajan in his June 23, 2014 interview with the Economic Times: “Perhaps, the monetary policy instruments could have been used differently. Tightening in small steps didn’t have an impact on inflation. The alternative could have been to raise rates sharply and we could had a better impact on inflation.”

simultaneously decides on how to allocate the total food expenditure across specific food categories, for example how much of the food expenditure budget will be spent on pulses versus how much on milk products. In the paper, we look at five food item groups: cereals; pulses (a grain legume); milk, eggs and meat; fruits and vegetables; and others (includes oil and fats, sugar, condiments and spices).

The two stage approach invokes the block independence idea or strong group-separability assumption of consumer preference theory, which implies that preferences among items within one broad consumption group are not dependent on the quantities consumed within other broad consumption groups. In other words, demand for specific non-food items is not influenced by the demand decisions for specific food items. A simple first stage budgeting, which involves a choice between only two broad expenditure groups namely food and non-food, allows us to greatly simplify the econometric estimation. Specifically, the adding condition of the expenditure weights – that budget share on food and non-food adds up to unity – implies that the first stage estimation can be reduced to a single equation least squares regression with coefficient restrictions rather than the estimation of a system of equations.

However, when it comes to spending decisions within specific expenditure categories, understanding demand for several food items requires demand modeling using a system of equations approach. This is important given that independent demand equations for various food items will not capture appropriately the demand for individual food items, as different food products can be substitutes or compliments with important cross-price effects. A system of equations approach is, therefore, employed to estimate the demand of various food items within the broader food category. Overall, the two stage budgeting procedure allows us to use reasonable assumptions regarding consumer behavior – the separability of consumer choice with respect to aggregate food and non-food consumption and the consumption of various food items, while preserving some important characteristics of demand for various food items.

More specifically, to investigate the consumption patterns of Indian households, we employ a two-stage Quadratic Almost Ideal Demand System (QUAIDS) model (Banks et al, 1997). QUAIDS is an extension of the Almost Ideal Demand System (AIDS) approach (Deaton and Muellbauer, 1980a) that includes a quadratic expenditure term to model non-linearity of Engel curves. In the literature, the AIDS-based approaches have been the preferred specification for estimating demand systems, owing to their consistency with consumer theory, exact aggregation properties, and ease of estimation. QUAIDS extensions, which provide a more accurate picture of consumer behavior across income groups, have proven useful in studying consumer food demand patterns, including in India (Mittal, 2010).

The first stage of the QUAIDS involves estimating a first-step budgeting equation, where consumers make a choice about how much of total expenditure will be devoted to food, conditional on the consumption of non-food goods and services, and household's demographic and socio-economic characteristics. The non-linearity in food expenditure –

implying that relatively lower share of income will be spent on food as income increases – is modeled through a quadratic expenditure term. Because we focus on only two broad categories of consumer expenditure, namely food and non-food, the adding-up restriction on the expenditure weights implies that the first stage estimation is reduced to a single equation least squares estimation. In the second stage, we then estimate a system of simultaneous equations, each representing demand for specific food item categories (cereals; pulses; milk, eggs and meat; fruits and vegetables; and others).

### ***General QUAIDS specification***

In the QUAIDS model, consumer's expenditure shares across the set of expenditure categories are defined by equations (1) and (2):

$$w_{i,j} = \frac{p_{i,j}q_{i,j}}{m_i} \quad (1)$$

$$\sum_{j=1}^N w_{i,j} = 1 \quad (2)$$

where  $p_{i,j}$  and  $q_{i,j}$  are price and quantity of item  $j$  purchased or consumed by an individual  $i$ ,  $w_{i,j}$  is expenditure weight on item  $j$  in individual  $i$ 's total expenditure (denoted by  $m_i$ ) across all related products  $j = \overline{1, N}$ . In the first stage of the consumer budgeting choice,  $w_{i,j}$  refers to the shares of expenditure on food versus non-food categories as a part of consumer's total expenditure. In the second budgeting stage,  $w_{i,j}$  refers to expenditure on specific food commodities within the consumer's total expenditure on food. Therefore, a general econometric specification prescribed by QUAIDS for expenditure weights takes the form:

$$w_{i,j} = \alpha_j + \sum_{n=1}^N \gamma_{j,n} \ln p_{i,n} + \beta_j \ln \frac{m_i}{P(\mathbf{p}_i)} + \frac{\lambda_j}{b(\mathbf{p}_i)} \left[ \ln \frac{m_i}{P(\mathbf{p}_i)} \right]^2 + \vartheta_{i,j} \quad (3)$$

where subscript  $i$  represents an individual consumer, while  $m_i$  denotes total per capita expenditure. As well,  $\mathbf{p}_i$  is the vector of prices faced by consumer  $i$ , and  $b(\mathbf{p}_i)$  is Cobb-Douglas price index defined as:

$$b(\mathbf{p}_i) \equiv \prod_{j=1}^N p_{i,j}^{\beta_j} \quad (4)$$

where  $\ln P(\mathbf{p}_i)$  is a price index defined as:

$$\ln P(\mathbf{p}_i) \equiv \alpha_0 + \sum_{n=1}^N \alpha_n \ln p_{i,n} + \frac{1}{2} \sum_{j=1}^N \sum_{n=1}^N \gamma_{j,n} \ln p_{i,j} \ln p_{i,n} \quad (5)$$

Note that the term  $\frac{m_i}{P(\mathbf{p}_i)}$  essentially represents a measure of an individual's real consumption. The quadratic term for the logarithm of consumption allows us to capture the non-linearity of consumption of specific products categories with respect to total expenditure on related

products.  $\vartheta_{i,j}$  denotes the residual term, with the vector of residuals  $\boldsymbol{\vartheta} = [\vartheta_1, \dots, \vartheta_N]$  which has a multivariate normal distribution with a covariance matrix of  $\Sigma$ . The adding up condition given by equation (2), that expenditure shares sum up to one, implies that  $\Sigma$  is singular and requires further restrictions on the coefficients::

$$\sum_{j=1}^N \alpha_j = 1, \quad \sum_{j=1}^N \beta_j = 0, \quad \sum_{j=1}^N \lambda_j = 0, \text{ and } \sum_{j=1}^N \gamma_{j,n} = 0 \quad \forall n \quad (6)$$

Also, two other conditions are imposed to ensure consistency with the economic theory of demand.

(a) Demand function homogeneity of degree zero in prices and income requires:

$$\sum_{n=1}^N \gamma_{j,n} = 0 \quad \forall j \quad (7)$$

(b) While Slutsky symmetry implies:

$$\gamma_{j,n} = \gamma_{n,j} \quad (8)$$

### ***First stage budgeting: estimating total expenditure on food***

In the first stage, we estimate the aggregate food demand equation compared to total expenditure on non-food. As mentioned earlier, the adding up condition (as there are only two goods of choice implying that the sum of weights must equal one) implies that consumer demand can be estimated within a single equation econometric specification. Imposing additional economic theory-based conditions on demand specification, namely the symmetry of the Slutsky matrix and the homogeneity of demand function of degree zero in prices and income, the general form of QUIADS specification equation (3) can be reduced to the following food demand equation, which can be estimated using least squares:

$$\frac{m_i^f}{Y_i} = \alpha_f + \gamma_{f,f} (\ln P_i^f - \ln P_i^{nf}) + \beta_f \ln \frac{Y_i}{P(\mathbf{p}_i)} + \frac{\lambda_f}{b(\mathbf{p}_i)} \left( \ln \frac{Y_i}{P(\mathbf{p}_i)} \right)^2 + \varepsilon_i \quad (9)$$

where consumer-specific aggregate price indexes  $b(\mathbf{p}_i)$  and  $P(\mathbf{p}_i)$  are defined according to equations (4) and (5), which after imposing above mentioned coefficient restrictions, reduce to:

$$\ln b(\mathbf{p}_i) = \beta_f (\ln P_i^f - \ln P_i^{nf}) \quad (10)$$

$$\ln P(\mathbf{p}_i) = \alpha_0 + \alpha_f (\ln P_i^f - \ln P_i^{nf}) + \ln P_i^{nf} + \frac{1}{2} \gamma_{f,f} (\ln P_i^f - \ln P_i^{nf})^2 \quad (11)$$

where  $m^f$  denotes total per capita expenditure on food,  $P^f$  and  $P^{nf}$  represent consumer-specific aggregate price index of food and non-food items, respectively,  $Y$  is per capita total consumption expenditure and  $\varepsilon$  is an error term.

Substituting aggregate price index specifications given by equations (10) and (11) into equation (9), we estimate the resulting food demand function using non-linear least squares using Indian household-level data. To calculate aggregate price indexes to be used in the first-stage of the budgeting procedure, consumer-specific food  $P^f$  and non-food price  $P^{nf}$  indexes are approximated using Stone price indexes <sup>7</sup>:

$$\ln P_i = \sum_{j=1}^N w_{i,j} \ln p_{i,j} \quad (12)$$

### ***Second stage budgeting: estimating expenditure on specific food categories***

In the second stage, we specify a QUAIDS system of individual food item demand equations (see for example Poi, 2002 and Poi, 2008) using the general QUAIDS structure outlined above, where expenditure weights represent expenditure on specific food categories as a share of consumer's total expenditure on food. In turn, the value of a consumer's total expenditure on food is the predicted value of aggregate food expenditure from the first stage estimation results.

Given consumer choice over multiple food items, the second stage QUAIDS specification is estimated as a system of non-linear seemingly unrelated regressions through iterated feasible generalized least squares, using the *Stata* routine described in Poi (2008).

## **B. Interpreting QUAIDS coefficients**

The QUAIDS coefficients are usually interpreted following basic transformation of the estimated raw coefficients of equation (3). Specifically, following Banks et al (1997), differentiating the expenditure shares in the demand equations described in equation (3) with respect to the logarithm of total expenditure ( $\ln m$ ) and the logarithm of prices, food expenditure elasticity and both compensated and uncompensated price elasticities ( $\mu_j$  and  $\mu_{j,n}$  respectively) can be calculated using expressions (13)- (14):

$$\mu_j \equiv \frac{\partial w_j}{\partial \ln m} = \beta_j + \frac{2\lambda_j}{b(\mathbf{p})} \ln \frac{m}{P(\mathbf{p})} \quad (13)$$

---

<sup>7</sup> Stone's (geometric) price index is a common price index approximation based on a linear approximate AIDS following Blanciforti and Green (1983).

$$\mu_{j,n} \equiv \frac{\partial w_j}{\partial \ln p_n} = \gamma_{j,n} - \mu_j (\alpha_n + \sum_{k=1}^N \gamma_{n,k} \ln p_k) - \frac{\lambda_j \beta_n}{b(\mathbf{p})} \left[ \ln \frac{m}{P(\mathbf{p})} \right]^2 \quad (14)$$

Consequently, the expenditure elasticity for the item  $j$  with respect to total expenditure can be computed as:

$$e_j = \frac{\mu_j}{w_j} + 1 \quad (15)$$

where  $e_j$  denotes the responsiveness of demand (expenditure) for item  $j$  with respect to changes in total expenditure. The value of  $e_j$  thus indicates the nature of a food item and how consumers perceive its importance with respect to total food budgets. More importantly, for the purpose of understanding India's food demand going forward, equation (15) allows us to understand how demand for food as well as demand for specific food items is likely to evolve with overall economic development in India. More generally, the value of  $e_j > 1$  is associated with so-called *normal goods* within food expenditure, while values between 0 and 1 correspond to so-called *normal necessities*. For such goods, demand will increase with overall income and expenditure, but their budget shares will decline. *Luxury goods* are those with demand elasticity of above 1, while *inferior goods* have negative elasticities.

To obtain price elasticities of food, we can use two alternative definitions of price elasticities based on the underlying demand equations: Marshallian (uncompensated) price elasticity, and Hicksian (compensated) price elasticity. The Marshallian (uncompensated) price elasticity equation is obtained by maximizing utility subject to consumer's budget constraint, while the Hicksian (compensated) demand is derived by solving the expenditure minimization problem keeping the utility level constant. The Marshallian uncompensated price elasticity can be obtained using the following transformation:

$$e_{j,n}^u = \frac{\mu_{j,n}}{w_j} - d_{j,n} \quad (16)$$

where  $d_{j,n}$  represents the Kronecker's delta ( $d_{j,n} = 1$  for  $j = n$  and  $d_{j,n} = 0$  for  $j \neq n$ ). While using the Slutsky equation, the Hicksian elasticities can be obtained using the following expression:

$$e_{j,n}^c = e_{j,n}^u + e_j w_j \quad (17)$$



### C. Supply Analysis

The consumer demand model we use for estimation and simulation purposes assumes that prices, in particular food prices, are exogenous. The assumption of exogeneity of prices, which we assume, is rather common in demand system modeling. From the aggregate economy perspective, this is equivalent to assuming that supply is perfectly elastic in prices, and that it is demand that adjusts to clear markets.<sup>8</sup> A perfectly elastic supply and market clearing demand is an appropriate assumption when dealing with traded goods, such as imported foods, in the case of small open economies. Of course, such assumptions may be somewhat unrealistic for the analysis of food supply in a country like India.

Nonetheless, existing studies of supply of food commodities production in India suggest that own price elasticities are low, particularly compared to own price elasticities of demand (Kumar and others, 2010). Therefore, the effect on prices from the shift in demand is likely to be only minimally mitigated by the response of supply, particularly in the near term. For simplicity of scenario analysis and pragmatic interpretation, particularly in the context of policies aimed at raising supply, we rely on simulating out-of-sample food market equilibrium dynamics assuming inelastic supply curves (i.e. supply remains constant in the short run).

## IV. RESULTS AND DISCUSSION

### A. Household Demand for Food

We focus on six food categories representing key food groups in the Indian household consumption basket: milk and products; egg, fish and meat; pulses; cereals; vegetables and fruits; and category of other foods which includes oil and fats, sugar, condiments and spices. Furthermore, the choice of these categories is also driven by distinct government policies – such as, policies related to production, pricing and provision – toward these sectors. These food categories together correspond to about 43 percent of household consumption expenditure, both in the CPI basket as well as in the household survey data.<sup>9 10</sup> Estimated expenditure weights on key food categories in the most recent household survey (NSSO 68<sup>th</sup>

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<sup>8</sup> Inelastic supply assumptions are usually more suitable to analyze demand for goods with fixed prices, as a result of administered price setting.

<sup>9</sup> Note that CPI expenditure categories, commonly attributed to the food basket, such as beverages (2 percent CPI weight), prepared meals (2.8 percent CPI weight), and pan, tobacco and intoxicant (2.1 percent CPI weight), are excluded from the analysis.

<sup>10</sup> The food purchases through the public distribution system (PDS) are included in household consumption at the purchase prices.

round for 2011/12) closely track weights in CPI Combined (Table 1), supporting the suitability of household survey based analysis to study implications of food demand dynamics for CPI inflation in India.

Table 1. Food expenditure weights in CPI-Combined and Household Survey Data  
(In percent of total household expenditure)

Food category	CPI Combined	Household survey (NSSO 68th round)
Egg, fish and meat	2.9	3.5
Milk and milk products	7.7	8.4
Cereals and products	14.6	12.9
Pulses and products	2.7	3.4
Vegetables and fruits	7.3	6.9
Other (oils and fats, sugar, condiments and spices)	7.5	8.1
<b>Total</b>	<b>42.7</b>	<b>43.2</b>

Sources: Haver Analytics; and IMF staff estimates.

Note: expenditure on non-alcoholic beverages, pan, tobacco and intoxicants, and prepared meals are not included.

### *First stage budgeting estimation results: total expenditure on food*

Estimates of consumer demand for food from the first stage budgeting exercise indicate clear heterogeneity in food demand patters across the income spectrum of Indian households:

Table 2. Food demand elasticities: first budgeting stage  
(sample mean values)

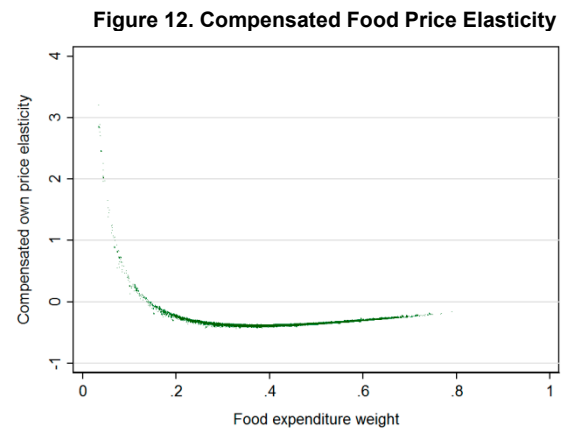
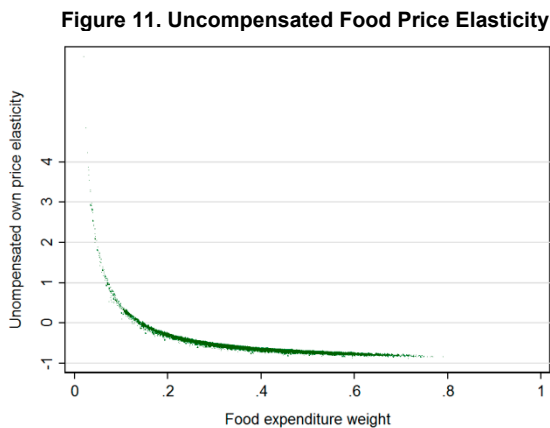
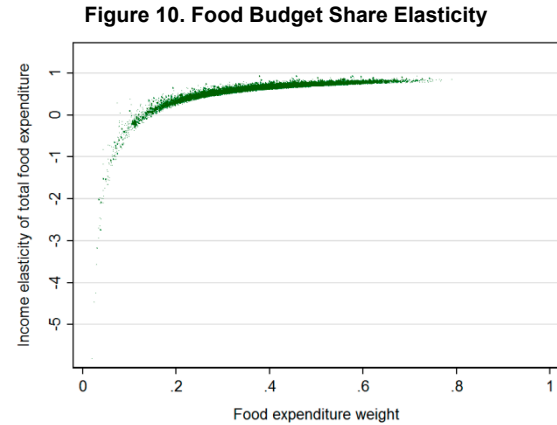
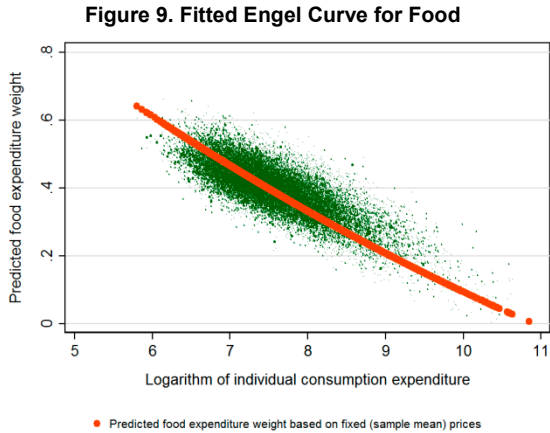
Income elasticity of total food expenditure		
0.640 (0.172)		
Uncompensated (Marshallian) price elasticity of total food expenditure		
Food prices	Non-food prices	
-0.627 (0.185)	-0.013 (0.023)	
Compensated (Hicksian) price elasticity of total food expenditure		
Food prices	Non-food prices	
-0.353 (0.086)	0.267 (0.122)	

Source: IMF staff estimates.

Note: Standard deviations relative to sample mean values reported in parenthesis

Estimates suggest that as the per capita income goes up by 1 percent the demand for food goes up by 0.64 percent. Similarly, a 1 percent increase in food prices result in 0.62 percent decline in total food expenditure, when the consumer is not compensated for the price

increase. However, if the consumer is compensated to maintain its level of welfare, the total expenditure on food goes down by 0.35 percent when food prices go up by 1 percent (see Table 2).



Sources: IMF staff estimates.

Figure 9 plots the weights of food expenditure (predicted by our model) against the log of individual incomes. As predicted by Engel's law, as income increases, households spend less and less on food (estimated weights on food expenditure declines). Figure 10 suggests that the households who spend a lot on food (have high weight on food expenditure), their income elasticity of food expenditure is also high. The two charts together suggest that the demand for food by poor households goes up by more when per capita income rises. Figures 11 and 12 present price elasticities of food with respect to food expenditure weights. It suggests that the elasticity is relative large for those who spend a lot on food.

### ***Second stage budgeting estimation results: expenditure on specific food categories***

Using expenditure weights for specific food categories and individual total food expenditure, we then go on to estimate demand functions for specific food categories. Econometric estimates of consumer demand for food from the first stage budgeting exercise indicate that

based on expenditure elasticities with respect to total food expenditure, we can essentially classify six food categories into three groups (Table 3):

- *High income elasticity products*: It includes milk products; egg fish and meat. On average the expenditure on these items (across all households) will go up disproportionately more than the increase in total food expenditure.
- *Unit income elasticity products*: It includes fruits and vegetables. On average the expenditure on these items (across all households) will rise at the same rate as the increase in total food expenditure.
- *Less-than-unity income elasticity products*: It includes pulses, cereals, and other products category. On average the expenditure on these items (across all households) will increase relatively less than the increase in total food expenditure.

The observed patterns are in line with the Bennis's law which states that with rising incomes, food consumption shifts away from simple starchy plant-dominated diets towards more nutritious and high value foods that include a range of dairy products, vegetables and fruits, and especially meat (Figures 13-18).

Table 3. Food expenditure demand elasticities: second budgeting stage  
(sample mean values, based on actual expenditure weights)

Expenditure elasticity: with respect to total expenditure on food	
Egg, fish and meat	1.321
Milk and milk products	1.590
Cereals and products	0.848
Pulses and products	0.666
Vegetables and fruits	1.000
Other (oils and fats, sugar, condiments and spices)	0.841

Source: IMF staff estimates.

The estimates of expenditure elasticities reported in Table 3 correspond to their mean values across all households, and thus do not take into account differences in food budgets across households. To get some insight into the possible impact of increase in food expenditures on the aggregate demand for specific food categories, taking into account differences in food budgets across households, we can reweight estimated elasticities by each household's actual expenditure on each of the food categories. The results reported in Table 3.1 are qualitatively similar, although magnitudes are closer to unity, suggesting that aggregate demand impact for high elasticity food commodities is somewhat lower than the simple mean elasticity estimates.

Table 3.1. Food expenditure demand elasticities: second budgeting stage  
(expenditure weighted values, based on actual expenditure weights)

Expenditure elasticity: with respect to total expenditure on food	
Egg, fish and meat	1.165
Milk and milk products	1.326
Cereals and products	0.845
Pulses and products	0.725
Vegetables and fruits	0.985
Other (oils and fats, sugar, condiments and spices)	0.848

Source: IMF staff estimates.

Note that in the aggregated expenditure elasticity analysis, we focused on the impact of a uniform percentage change in household total food expenditure. A further insight into implications for aggregate demand for specific food items can be obtained by estimating the sensitivity of demand for specific food groups with respect to increase in total household expenditure. We thus assume a uniform percent change in total household expenditure across all households and account for the impact of interaction of household expenditures with the corresponding variation in elasticities of households total food expenditure and the expenditures on specific food items. The results (Table 3.2) indicate a significantly higher increase in demand for milk and milk products and the category of egg, fish and meat products compared to pulses (the lowest elasticity product category), with relative elasticities of 1.7 and 1.5, respectively. Moreover, each of the corresponding budget elasticities for cereals, vegetables and fruits, as well as other food categories is about 1.2 times higher than the budget elasticity of pulses, suggesting that the relative demand pressures for some food categories can be significantly higher as households' incomes grow.

Table 3.2. Food expenditure demand elasticities: second budgeting stage  
(expenditure weighted values, based on actual expenditure weights)

Expenditure elasticity: with respect to total household expenditure		
		Relative to pulses
Egg, fish and meat	0.592	1.515
Milk and milk products	0.645	1.650
Cereals and products	0.468	1.196
Pulses and products	0.391	1.000
Vegetables and fruits	0.484	1.238
Other (oils and fats, sugar, condimen	0.459	1.173

Source: IMF staff estimates.

Own price uncompensated demand elasticities reported in Table 4 provide some insight into the extent of sensitivity of demand for specific food items with respect to prices. Specifically, holding total household food expenditure constant, demand for egg, fish, and meat and related products is least sensitive to changes in milk prices, while the demand for other proteins (milk, and pulses) responds almost one to one. This also implies that to induce

demand adjustment for milk products, for example in response to a limited supply of milk, a much stronger response of milk prices would be required to equilibrate its supply and demand. Finally, the (uncompensated) cross-price elasticities reported in Table 4 indicate some extent of complementarity among most of the food categories. For example, a 1 percent increase in the price of eggs, fish and meat leads to a decline in the demand for milk by about 0.1 percent. However, some foods also appear to be substitutes. Notably, values of uncompensated price elasticities indicate that cereals are substitutes for proteins: milk and egg, fish and meat, and also pulses. In other words, when prices of proteins rise while foods budgets stay unchanged, consumption is switched to cereals and related products.

Table 4. Uncompensated (Marshallian) price elasticities: second budgeting stage  
(sample mean values, based on actual expenditure weights)

	Egg, fish and meat	Milk and milk products	Cereals and products	Pulses and products	Vegetables and fruits	Other
Egg, fish and meat	<b>-0.563</b>	-0.026	-0.044	-0.134	-0.169	-0.080
Milk and milk products	-0.096	<b>-0.880</b>	-0.102	-0.216	-0.091	-0.089
Cereals and products	0.020	0.013	<b>-0.858</b>	0.008	-0.017	0.028
Pulses and products	-0.045	-0.068	0.015	<b>-0.704</b>	0.002	0.047
Vegetables and fruits	-0.254	-0.028	-0.035	-0.052	<b>-0.754</b>	0.001
Other	-0.062	-0.012	0.024	0.098	0.030	<b>-0.907</b>

Source: IMF staff estimates.

Hicksian price elasticities provide somewhat different insight into food demand patterns in India. Most of the food categories emerge as substitutes. To achieve a comparable level of utility following an increase in the price of other products, the demand for most food products goes up, compensating for the decline in the consumption of food items whose prices have gone up. Perhaps the only food category which is a noticeable exception is vegetables and fruits with respect to sensitivity to prices of eggs, fish, and meat. As price of this category of food goes up, the demand for vegetables and fruits needs to decline, in part as consumers substitute egg, meat, and fish for other proteins, namely pulses and milk.

Table 5. Compensated (Hicksian) price elasticities: second budgeting stage  
(sample mean values, based on actual expenditure weights)

	Egg, fish and meat	Milk and milk products	Cereals and products	Pulses and products	Vegetables and fruits	Other
Egg, fish and meat	<b>-0.395</b>	0.142	0.124	0.034	-0.001	0.088
Milk and milk products	0.125	<b>-0.659</b>	0.119	0.004	0.129	0.131
Cereals and products	0.255	0.248	<b>-0.623</b>	0.243	0.218	0.263
Pulses and products	0.012	-0.011	0.072	<b>-0.647</b>	0.059	0.105
Vegetables and fruits	-0.086	0.141	0.133	0.117	<b>-0.586</b>	0.169
Other	0.090	0.139	0.175	0.249	0.181	<b>-0.756</b>

Source: IMF staff estimates.

Figure 13. Fitted Engel Curve: Egg, Fish, and Meat

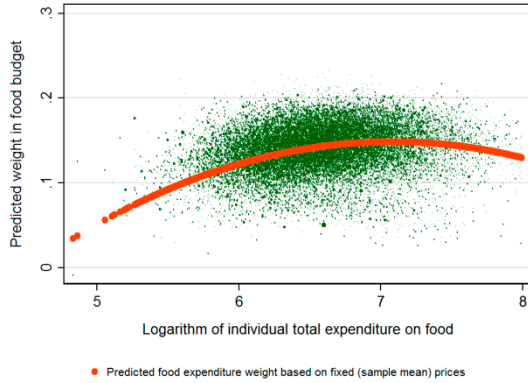


Figure 14. Fitted Engel Curve: Milk and Products

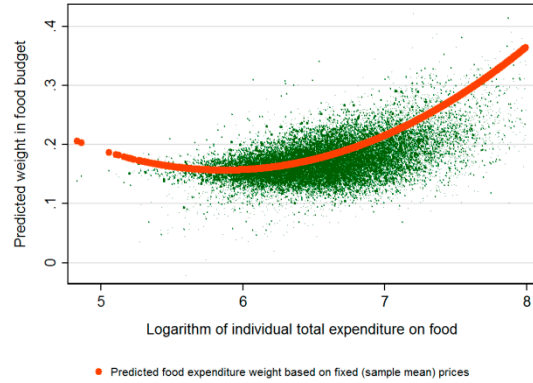


Figure 15. Fitted Engel Curve: Cereals

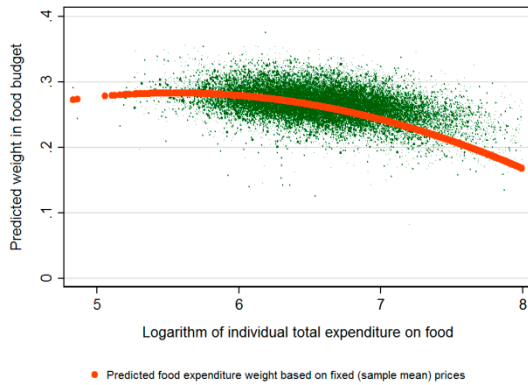


Figure 16. Fitted Engel Curve: Pulses

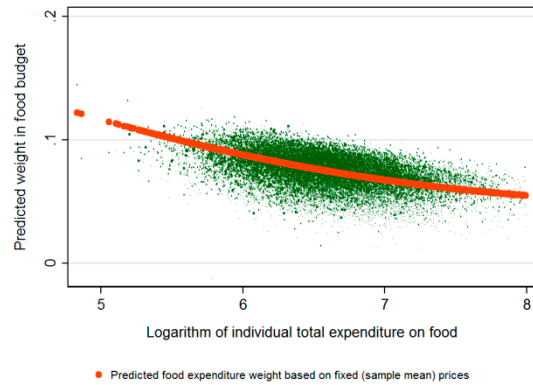


Figure 17. Fitted Engel Curve: Vegetables and Fruits

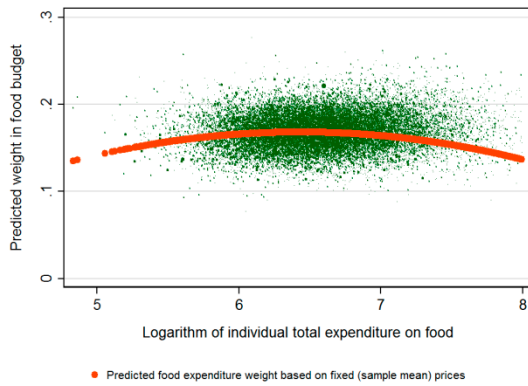
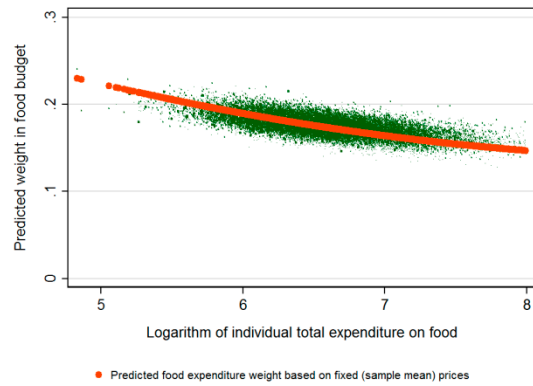


Figure 18. Fitted Engel Curve: Other Products



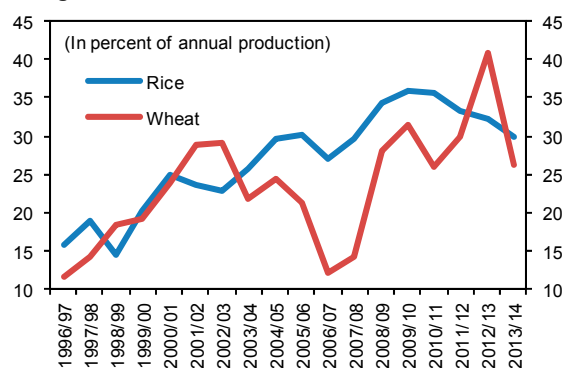
Sources: IMF staff estimates.

### *Food Subsidies and Some Distributional Aspects*

The Indian Government procures a substantial portion of the domestic output of cereals. This provides mainly for the needs of the targeted public distribution system (TPDS), other welfare schemes, and maintenance of buffer stocks. Note that in recent years, the share of

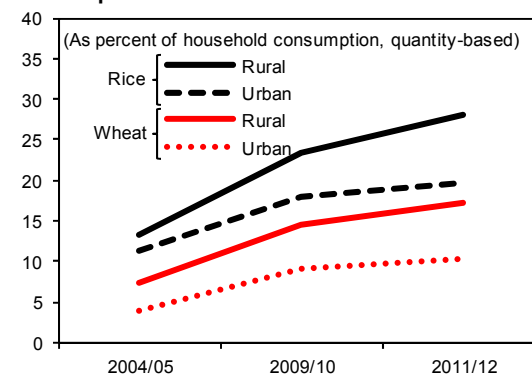
public procurement has risen substantially (Figure 19), from an average of about 25 percent during 2002/03–2007/08 to about 32 percent during 2008/09–2013/14, which has prompted criticism of state’s growing role in the market for cereals (CACP, 2013a). Similarly, the share of PDS purchase in consumption has also increased considerably (Figure 20). In the case of rural households consumption, between 2004/05 and 2011/12, the share of rice purchases from the PDS rose from 13 percent to 28 percent, and the share of wheat rose from 7 to 17 percent. For urban households, the increase was from 11 to 20 percent for rice, and from 4 to 11 percent for wheat.

**Figure 19. Procurement trend of rice and wheat**



Sources: CEIC; and IMF staff calculations.

**Figure 20. The share of PDS purchase of cereals in consumption**

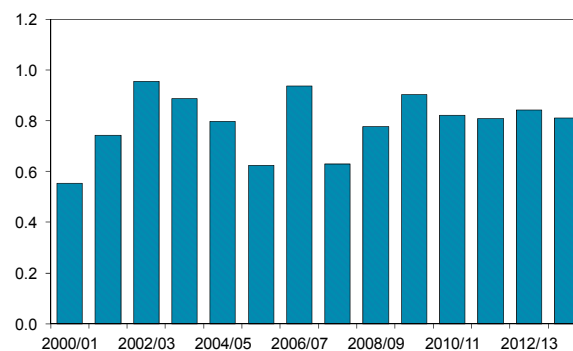


Source: National Sample Survey Office.

With a sizable share of subsidized cereals in the consumption basket of many households, average price of cereals (PDS and open market) paid by households is below both the open market prices and the minimum support price that a cereal producer can receive through open ended public procurement system. As a result of subsidized pricing to consumers (Figure 21), the weight on PDS cereals derived from expenditures is significantly less than that on the basis of quantities. For example, rice from PDS in CPI Combined, which tracks budget shares, is about 8 percent of total expenditure on rice, while the share of quantity of rice from PDS is around 25 percent of the total quantity. For wheat, the discrepancy is also non-trivial: 6 percent of expenditure on PDS wheat compared to 16 percent of quantity. These weights imply that on average in 2011/12, the price of rice from PDS was about 1/4th of the open market price, while the price of wheat from PDS was about 1/3rd of its open market price (see also Basu and Das, 2014).

The share of rice consumed from PDS is significantly higher for poorer households, as benefiting from TPDS, in particular BPL (Below Poverty Line) and AAY (Antyodaya Anna Yojana) schemes, as poorer household essentially face a different set of prices of cereals than the richer households. As our

**Figure 21. Government Food Subsidies**  
(As a percent of GDP)



Source: IMF staff data.



demand specification does not account for possible links between the rupee amount of each household's budget and the available prices of cereals for a household, for poorer households we may attribute relatively higher cereal consumption to the lower price rather than to their smaller budget<sup>11</sup>. In other words, the estimated demand system is conditional on the distribution of cereal prices with respect to the level of household budget, which in practice is ensured through in-kind nature of the TPDS system. Moreover, it does not account for leakages from the PDS, which are estimated to be large (CACP, 2012). As a result, our estimated demand system may not be fully capturing the effects of these distortions, and is only suitable to study demand under the existing food distribution policy and associated subsidies.

## B. Supply Dynamics

Estimates of domestic supply growth over the past decade suggest that products facing relatively higher demand growth have also seen relatively higher supply growth (Table 6). For example, the growth rate of domestic supply of cereals has been about half of that of animal-based proteins. Therefore, if relatively higher supply growth of food commodities with higher expenditure elasticities can be sustained going forward, it will help contain relative food-price pressures.

Table 6. Average Growth in Domestic Supply  
(in percent per year)

	2005/06 - 2012/13
Egg, fish and meat	5.4%
Milk and milk products	4.6%
Cereals and products	2.0%
Pulses and products	4.9%
Vegetables and fruits	4.7%
Other	3.4%

Source: CEIC; and IMF staff estimates.

Our domestic supply series estimates are based on the commodity flow approach, which adjusts quantities of domestic production for commodity-wise net exports as well as net changes in average buffer stocks during a year in the case of cereals. This approach is,

<sup>11</sup> For example, the bottom decile rural households have a budget share of cereals of about one fourth, and it declines to less than one tenth for the top decile. In urban India, the share of cereals falls from slightly less than one fifth to just 3-4 percent for the top decile households.

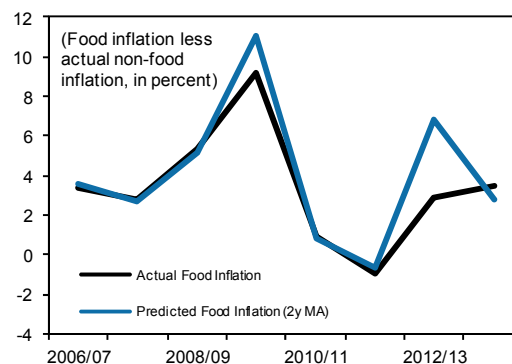
however, not without limitations as it does not adjust for intermediate consumption, such as related to seed, feed, and wastage.<sup>12</sup>

### C. Equilibrium Relative Price Dynamics

We then turn to evaluating actual relative food price dynamics over the past decade with respect to the model-implied equilibrium relative food price dynamics. We should note that the results should not be seen as indicating a causal interpretation of drivers of food inflation. Rather, we aim to establish whether the actual relative food price dynamics over the past decade has been consistent with the developments of food supply and household demand. To do that we solve for the path of relative food price inflation that would clear demand and supply of food, contingent on the dynamics of estimated demand system and on the historic paths of: (i) supply growth of the six major food categories, (ii) actual growth of real private final consumption expenditure, (iii) non-food inflation, and (iv) population growth. Although distributional aspects are likely to have non-trivial implications for aggregate price dynamics, we set the consumption basket in 2011/12—specifically, with respect to expenditure weights and relative price levels corresponding to the sample mean expenditure level – as the starting point and solve for inflation dynamics recursively (forward and backward).

Our simulations suggest that the actual food inflation dynamics track closely the developments in food supply as well as consumer demand during 2005/06–2013/14. As retail prices normally respond to supply shocks with a lag, particularly the prices of Rabi crops that essentially affect supply over the next fiscal year, we compare the actual relative food price dynamics to a two-year average of model-implied relative food price dynamics (Figure 22). With the exception of two years, 2009/10 and 2012/13, which were both outliers in terms of adverse monsoon and subpar agricultural output, the model-implied dynamics appear to match closely the actual food price developments. In other words, in the cases of adverse supply shocks, the model seems to overstate the rise in food prices over a two-year period.

**Figure 22. Relative Food Inflation: Predicted vs. Actual**



Sources: IMF staff estimates.

Note: Predicted relative food inflation is calculated as a solution of a general equilibrium system with demand specified using an estimated two-stage Quadratic Almost Ideal Demand System for India and historic domestic supply growth rate for six major food expenditure categories, overall private consumption and non-food inflation.

<sup>12</sup> Our estimates are comparable to category-wise household private final consumption expenditures in the national accounts statistics, which are quantity-based but are not available at a comparable level of disaggregation for key commodity groupings, namely cereals and pulses in the 2011/12 base year series.

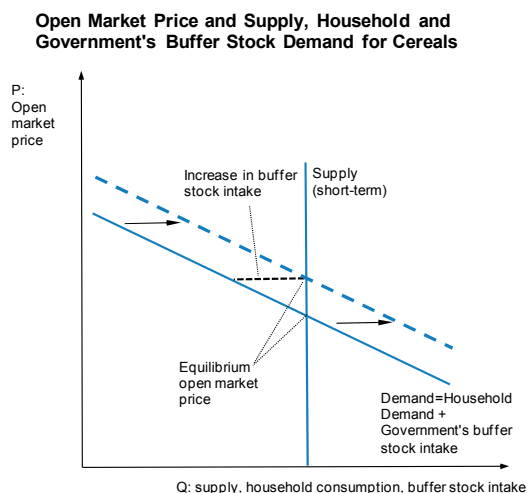
## D. Buffer Stocks and Minimum Support Prices

### *Buffer Stocks*

In this section, we analyze the impact of buffer stock build-up on India's relative food inflation over the past decade. Specifically, we estimate relative food inflation due to diminished net supply of cereals into the market as a result of the buffer stocks build up. Additionally, we also estimate the impact of a hypothetical (and counter-factual) pro-active buffer stock liquidation policy on relative food inflation volatility.

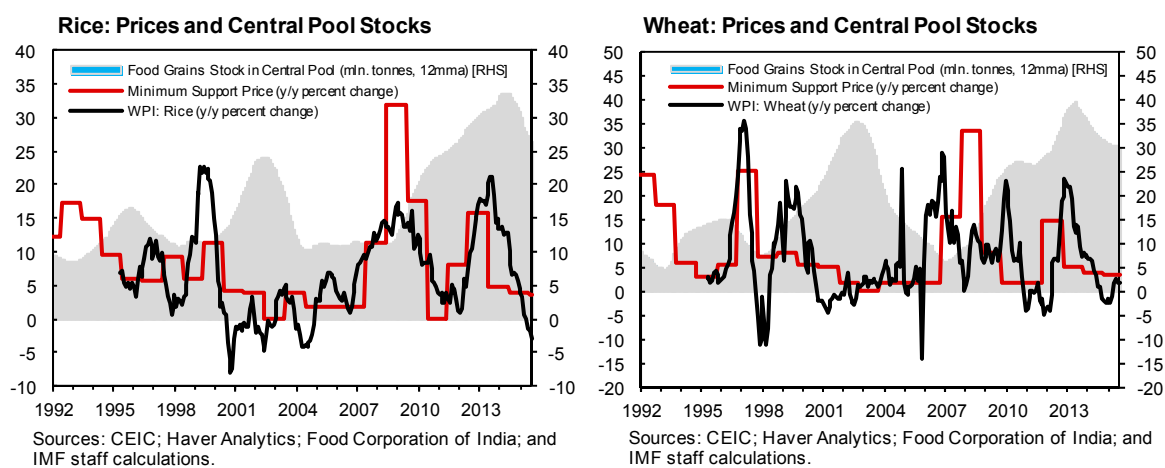
It has been frequently argued that excessive build-up of buffer stocks for cereals – rice and wheat – have contributed to India's inflationary pressures in the past several years (CACP, 2013a). The cumulative build-up of the buffer stock of rice over a 6-year period between 2007/08 and 2012/13 was close to 20 million tons, while the average production was about 100 million tons. The build-up of wheat stocks was even more significant, as the average wheat stock in the Central Pool during 2012/13 exceeded average stocks in 2007/08 by about 30 million tons, as production averaged about 85 million tons per year. Rice and wheat intake into the Central Pool averaged about 4 and nearly 7 percent of annual output, respectively, during this period. As a result, by July 2012, India's stocks of rice and wheat accounted for more than 6 and 7 percent of the world's total rice and wheat utilization, respectively (Saini and Kozicka, 2014). During the last five years, on average, actual buffer stocks held with the Food Corporation of India (FCI) were more than double the norms, as mentioned in the paper earlier. The underlying reasons for this situation have been several, such as exports bans, open ended procurement, and other distortions, although a key reason appears to be a lack of pro-active liquidation policy. The inefficiency of the buffer stock policy have been aggravated by the significant costs of carrying excess stocks, considering that the economic cost to the FCI for acquiring, storing, and distributing food grains have been about 40 to 50 percent more than the procurement prices (Gulati and others, 2012).

In practice, MSP increases are announced in advance of the agricultural season, and so the actual intake to buffer stock following the harvest has a further impact on inflation dynamics, as it reduces quantity of cereals available for households' open market purchases, especially during a poor output period. Even though MSPs essentially provide a floor for open market prices, in part due to the open ended procurement policy, actual post-harvest buffer stock intake and household demand define the eventual open market prices. The diagram below illustrates a simplified interaction of post harvest short-term supply and demand for cereals. If we abstract away



from international trade aspects, we can assume that post-harvest short-term cereal supply curve is vertical. In addition, we assume that government's decision with regard to buffer stock build-up does not depend on the price paid, which implies a vertical government demand curve. The increase in government demand for buffer stock buildup leads to a parallel rightward shift of the total cereal demand curve. Under these assumptions of fixed supply and fixed government demand, the quantity available for households' open market purchases is reduced by a fixed amount, implying that the inflationary impact of buffer stock intake can be assessed solely using the structure of household demand.

**Figure 23. Prices and Central Pool Stocks**



Indeed, actual monthly price dynamics suggest that WPI cereal inflation during the months of peak buffer stock intake significantly exceeded MSP increases (Figure 23). For example, by mid 2013 wholesale price inflation for rice exceeded 20 percent compared to the MSP growth of around 15 percent. For wheat, the buffer stock intake was even more pronounced and so was the departure of wholesale price inflation from minimum support prices.

Therefore, we can in principle consider alternative scenarios of historic relative food price dynamics under different scenarios of the evolution of buffer stocks, conditional on MSP policies and output. In other words, intake and liquidation of stocks can smooth consumption and stabilize prices.

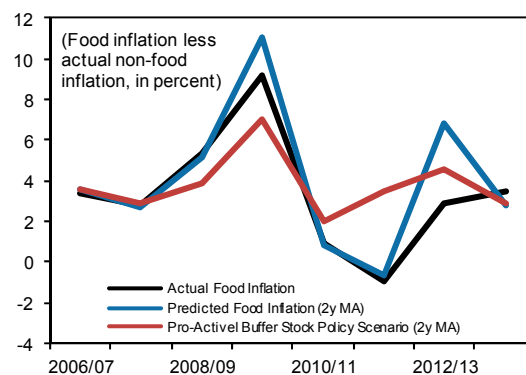
Specifically, we model relative food inflation dynamics under an alternative (counter-factual) scenario with two key properties related to buffer stock policies:

First, we take into account the revised buffer stock norms and calculating the effect on inflation of releasing the excess stock relative to the new norm on relative food inflation. Specifically, we adopt the recently approved buffer norms of the Government of India,

reflecting the needs of the National Food Security Act.<sup>13</sup> Our scenario analysis has a reduced net overall buffer stock intake between 2006/07 and 2013/14 that results in average stocks in the Central Pool during 2013/14 reaching close to the revised norms levels. More specifically, we assume a lower cumulative buffer stock intake between July 2007 and July 2012 by about 15 mmt for rice and by about 20 mmt for wheat. Our estimates suggest that this would have resulted in a reduction in food inflation by about ½ percentage points per year compared to the actual aggregate stock intake during 2006/07–2012/13, assuming the government had continued to subsidize PDS distribution of cereals.

Second, we consider a pro-active cereal liquidation policy – releasing more from the buffer stocks in a year of low production, and increasing intake during a good harvest year to stabilize the growth rate of cereal consumption and, therefore, market prices – and estimate its impact on reducing relative food inflation volatility. Conditional on the implementation of revised buffer stock norms by mid-2013, this smoothing of growth rate of cereal consumption at slightly below 1½ percent per year through a pro-active intake and release of buffer stocks could have reduced the standard deviation of historic relative food inflation during this period by half – from about ¾ percentage points to just about 1½ (Figure 24). Note that by focusing only on modeling relative food inflation and keeping the path of non-food inflation unchanged we ignore potential second-round effects of elevated food inflation on core inflation, which are non-trivial (see Anand and Tulin, 2014). Therefore, our exercise likely understates the additional impact on aggregate retail inflation, particularly at times of elevated food inflation.

**Figure 24. Relative Food Inflation: Predicted vs. Actual**



Sources: IMF staff estimates.

### ***Minimum Support Prices***

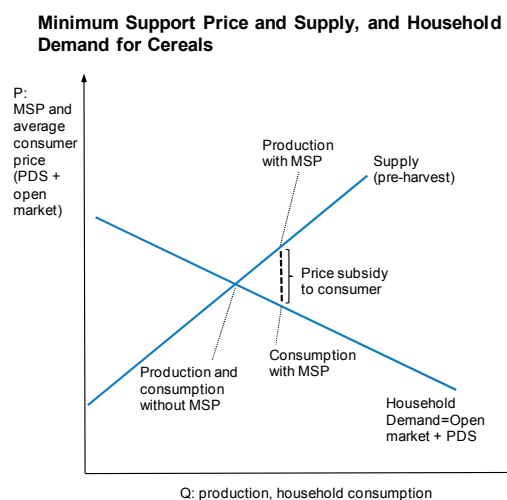
The strong building up of buffer stocks was undoubtedly aided by large rises in minimum support prices, which during this period averaged about 13 percent per year, even as headline CPI inflation averaged about 9 percent and WPI inflation slightly above 7 percent. Although minimum support prices are intended to provide a floor for market prices, substantial increases in minimum support prices in the recent years were generally followed by rising inflation in key agricultural crops (Rajan, 2014). This suggests that MSP increases have played a role in fueling inflationary pressures, including by chipping away the production of

<sup>13</sup>The revised norms introduce greater differentiation of buffer norms across different quarters of a year, with the maximum combined requirement of about 27.5 million metric tonnes (mmt) of wheat and about 13.5 mmt of rice to be maintained on July 1. As of July 1 2012, which was a near peak stock holding period, the FCI stocks amounted to 49.8 mmt of wheat and 30.7 mmt of rice.

other crops. Nonetheless, incentive schemes, such as MSP, have also been found to have contributed to increased cereal production during this period<sup>14</sup>. Growth of cereal production averaged about 1¼ percent per year during 1995/96–2005/06 when the growth of MSPs for cereals remained close to headline CPI and WPI inflation. However, since then the growth of cereal production rose to an average of about 2¾ percent per year, while the growth of MSPs exceeded headline WPI inflation by about 4½ and headline CPI inflation by about 2 percentage points. Kozicka and others (2014) argue that the MSPs likely have helped increase cereal production in recent years, which helped underpin rebuilding of the buffer stocks of cereals and increase household consumption. Although as a policy instrument, the role of MSPs was much broader, as by design they ensure remunerative and stable price environment which was also equitable.

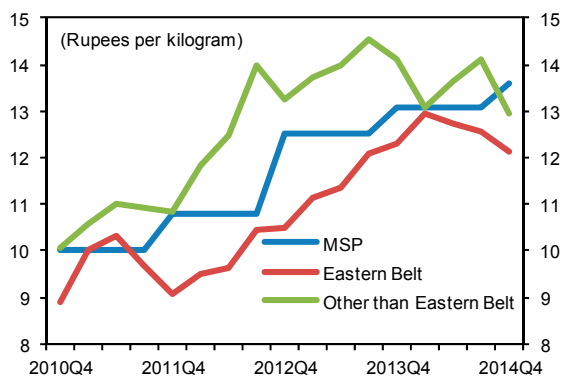
Thus, even though the buffer stocks build up over the past decade was very strong, in part enabled by procurement policies – including minimum support prices, the build-up of the buffer stocks appears to be less than the estimated cereal production gains caused in part by strong growth in minimum support prices. Specifically, the increase in the average buffer stock between 2006/07 and 2013/14 was equivalent to lowering the growth rate of household cereal consumption during this period by about ¾ percentage points per year, which is about half of estimated production gains using the estimates from Kozicka and others (2014). Given the government’s policy to make available cereals at subsidized prices, this meant increasing fiscal costs of providing food subsidy.

Under the price floor policy of MSP and the assumption that MSP results in increased production relative to the market equilibrium without government subsidies, in the absence of buffer stock build-up, ensuring post-harvest market clearing of increased supply of cereals necessitates a subsidy to a consumer. Indeed, the average consumer prices of cereals purchased at subsidized prices from PDS and from the open market tended to be below the MSPs, even though the open market wholesale prices of cereals generally exceed MSPs (Figures 25 and 26). For example, cereal expenditure shares and consumption volumes suggest that PDS prices are about 1/4<sup>th</sup> the retail prices for rice, and 1/3<sup>rd</sup> the retail prices for wheat.



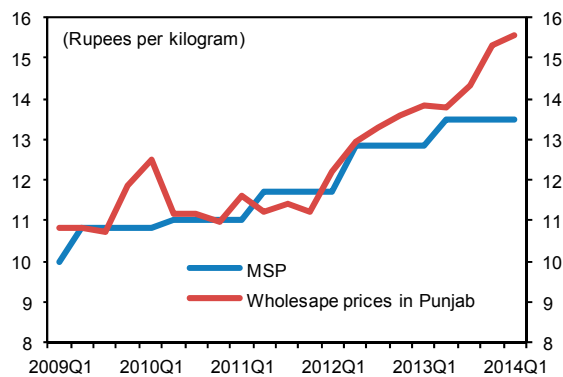
<sup>14</sup> Using estimates of cereal’s supply elasticity of about 0.3 with respect to MSP (WPI-deflated) reported by Kozicka and others (2014), the MSPs’ impact on production may have been significant. Specifically, MSP might have accounted for nearly three quarters of the 1¼ percent average annual increase in rice production and close to about a half of the 3 percent average annual increase in wheat production during this period.

Figure 25. Wholesale Prices and MSPs: Paddy



Source: India's Commission for Agricultural Costs and Prices.

Figure 26. Wholesale Prices and MSPs: Wheat



Source: India's Commission for Agricultural Costs and Prices.

Thus, from the perspective of a consumer, if higher minimum support prices lead to higher supply and thus higher consumption of cereals, higher MSP might then also result in lower inflation (quantity-weighted) for cereals relative to non-food inflation. However, increased availability of cereals may also lead to further demand pressures for non-cereal food commodities, including as a result of their reduced supply due to MSP-generated production distortions. Also, given the government's policy to enhance cereals supply and make cereals available to household at subsidized prices, this means increasing fiscal costs of MSP policies. However, given a relatively large share of cereals in overall household consumption, the MSP mechanism in combination with open ended procurement may lead to overall inflationary pressures. In other words, even though relative food inflation may end up lower, the non-food inflation and also headline inflation can rise significantly as it is influenced by MSP inflation.

Note that our simulation framework is aimed at explaining relative food inflation for a given level of non-food inflation and cannot be construed as establishing a causal relationship. A possible simulation approach, of course, could be to tie food and non-food prices to administered prices, including MSPs, and then solve for inflation dynamics conditional on administered price inflation. It is not obvious to what extent this is an informative exercise as, while not trivial, products subject to MSPs constitute a relatively small share of total consumption. For identifying overall inflationary impact of MSPs, time series techniques with causal relationship are better suited. For example, Sonna and others (2014) find that a 1 percentage point increase in the production-weighted MSP of rice and wheat is associated with about 0.3 percentage point increase in food inflation, controlling for real incomes, demand for protein, and agricultural input costs. In addition, on the basis of the weak exogeneity tests, they also conclude that in the short-run MSPs have a statistically significant impact on food inflation. Similarly, Anand and Tulin (2014), using a reduced-form dynamic general equilibrium model for India, show that food inflation shocks can lead to a significant increase in core inflation.

### *Exploring Linkages between Domestic and International Market Prices of Cereals*

Government decisions on MSPs are made on the recommendations of the Commission for Agricultural Costs and Prices. The commission takes into account a large number of factors in formulating its recommendations, key among which are domestic cereal production costs as well as the international price situation. International market aspects have always been important to Indian government policy toward cereals. Indeed, FCI was established in 1965 against the backdrop of India's major shortage of grains and a massive import bill. Over time, as production increased substantially, India has emerged as a net cereal exporter and the largest exporter of rice in the world. Nonetheless, India's policy measures to isolate domestic cereal prices from volatility of international market prices suggest that international market price dynamics remain non-trivial.

Empirical evidence suggests that domestic prices of wheat and rice co-move with prices in international markets (Figures 27 and 28). Our econometric analysis using vector-error correction models of average domestic farm gate (wholesale) and international market prices (converted into rupees) and post-1992 quarterly data indicates that for both cereals, the coefficients on the domestic price in the long-term relationship are statistically significant and are close to one (0.97 for rice and 1.07 for wheat). We find international market prices to be weakly exogenous to domestic prices, while the estimated error correction terms for domestic prices are statistically significant and are about 0.06 for rice and 0.08 for wheat. Moreover, econometric specifications with MSPs as measures of domestic prices give similar results. These results lend credence to the fact that international prices influence the wholesale prices and also MSPs, both in the short- and the long-run (Figure 29).

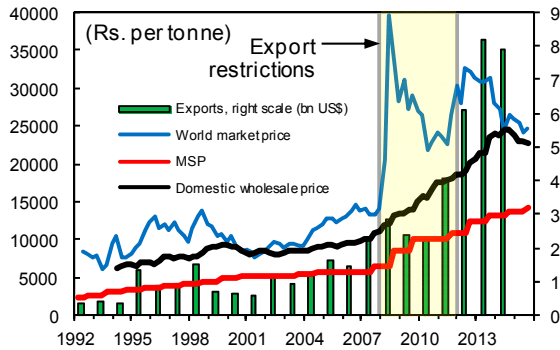
Our econometric analysis also suggests that hikes in MSPs for cereals do not have lasting impact on cereal inflation (Figure 28). Vector-error correction models of domestic farm gate prices and MSPs indicate that both wheat and rice farm gate prices are weakly exogenous to MSPs, which suggest that MSPs rather than domestic market prices tend to adjust to short-term deviations from their long-term relationships. In addition, impulse responses of farm gate prices for both rice and wheat to hikes in MSPs do not indicate presence of a lasting impact on cereal inflation. On the contrary, the responses of MSPs to shocks to wholesale prices for both cereals are statistically significant, covering on average about  $\frac{3}{4}$  of the wholesale prices shock over one year. The empirical evidence suggests that except in the short-term, MSPs tend to react to changes in wholesale prices, rather than the other way around. This implies that the inflationary impact of MSP hikes may be more trivial than has been argued by some economists (Bhalla, 2014). Moreover, as MSPs and domestic wholesale prices are influenced by and move in line with international prices, the global market price will remain important in defining Indian cereal prices in the long-term.

Thus, the guiding principle for MSPs should be the alignment of domestic and international prices along the long-term trends, while guarding against excessive domestic price volatility through temporary safeguards, as has been advocated by the CACP (CACP, 2013b). The



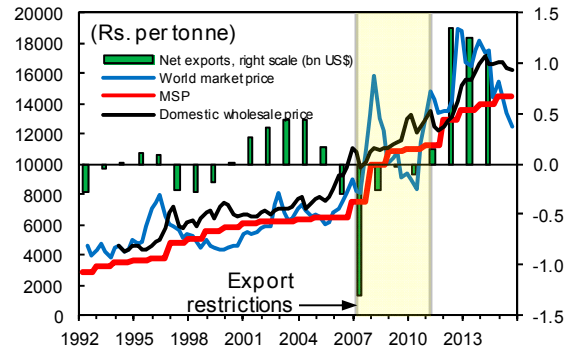
current soft international commodity price outlook suggests that Indian cereal inflation is likely to remain benign. In addition, off-loading of excessive cereal buffer stocks into open markets or through exports could have an additional softening impact on prices. Indeed, against the background of two subpar monsoons, in response to a drop in global wheat prices, India has recently imposed a wheat import duty for the first time in nearly a decade.

**Figure 27. Domestic and International Prices of Rice**



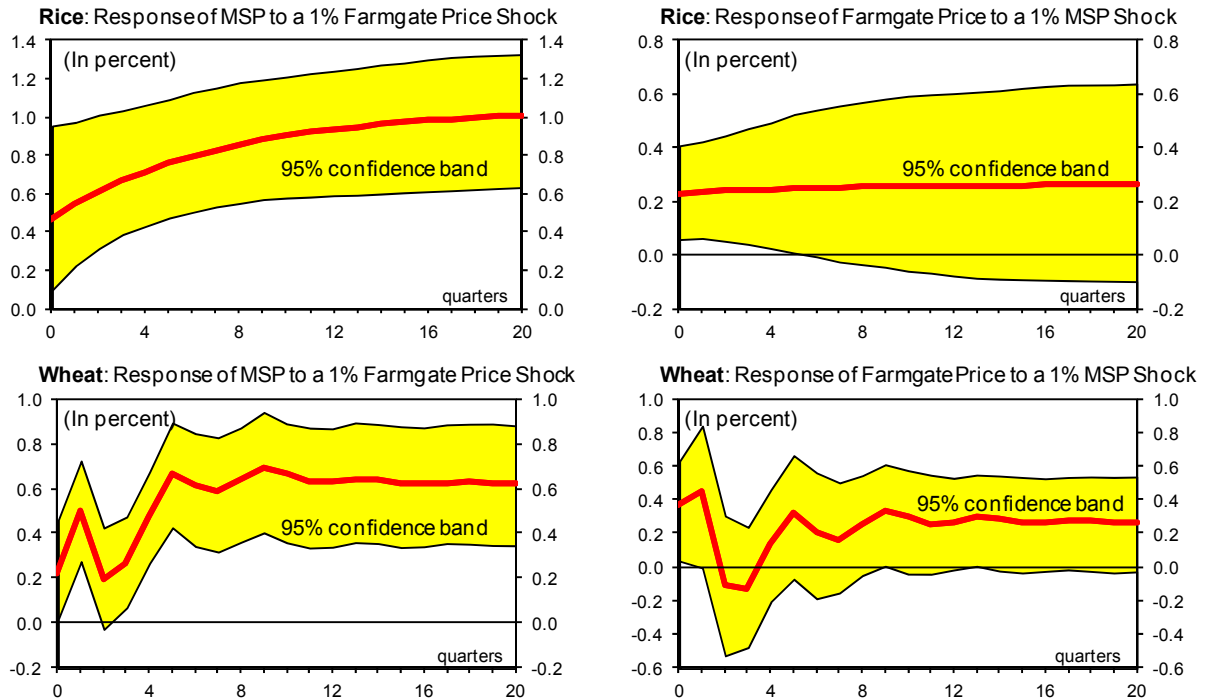
Sources: CEIC; Haver Analytics; World Bank; and IMF staff estimates.  
Notes: Domestic wholesale price is average across top ten rice producing states. World market price is rice (Thailand) 5 percent broken milled white rice.

**Figure 28. Domestic and International Prices of Wheat**



Sources: CEIC; Haver Analytics; World Bank; and IMF staff estimates.  
Notes: Domestic wholesale price average across top ten rice producing states. World market price is the average of Hard Red Winter and Soft Red Winter wheat export price delivered at US Gulf port for 30 days shipment.

**Figure 29. Generalized Impulse Responses: Domestic Farmgate Prices and MSPs for Rice and Wheat**



Source: IMF staff estimates.

### E. Implications for the Monetary Policy

Our modeling framework ignores that agricultural supply could be responsive to prices. By imposing adjustment only on prices and demand, it may not be ideal to study situations when supply is price-elastic. It may be particularly limiting when analyzing long-term food inflation dynamics.

As discussed above, the approach of abstracting away from explicit modeling of food supply is not without limitations<sup>15</sup>, and the estimated inflation outcomes are likely to have an upward bias. Nonetheless, as own price supply elasticities are usually found to be significantly below demand elasticities, responsiveness of supply to mitigate the impact of demand on prices may be rather limited, particularly over the near term. The Food and Agriculture Policy Research Institute database<sup>16</sup>, for example, indicates the price elasticities of rice supply are usually close to 0.2, with the value of 0.25 in Bangladesh, 0.16 in China, and 0.11 in India. The price elasticities of response for wheat are slightly higher, averaging for example to 0.33 in Australia, 0.43 in Brazil, 0.09 in China, and 0.29 in India. In the case of more recent studies on India, Kumar and others (2010) report similar estimates of own price elasticities of supply – 0.24 for rice, 0.22 for wheat, and 0.17 for pulses. Supply elasticities with respect to MSPs, estimated by Kozicka and others (2014), are somewhat higher (0.27 for rice and 0.33 for wheat), which might be explained by the low risk related to the MSP. Finally, estimates of long-term supply elasticity to a sustained increase in the relative price of cereals are about 0.35 for rice but 0.72 for wheat (Kozicka and others, 2014).

Next we thus estimate relative food inflation dynamics under different supply growth scenarios (Table 7). Under the historic supply growth scenario, average growth rates of domestic food supply in the recent decade, food inflation would exceed non-food inflation by about 3 percentage points per year, thus contributing about 1¼ to the headline inflation in excess of underlying non-food inflation. Under a preferred growth scenario, which assumes that supply growth rates of all food categories is raised by about 1 percentage point per year, food inflation would exceed non-food inflation by only about ½ of a percentage point. Finally, we also consider a conservative growth scenario which assumes growth rate for cereal production at about ¾ percent per year, which would imply stagnant cereal productivity and/or absence of policy support. In this scenario, food inflation

Table 7. Projection Assumptions  
(in percent per year)

	Historic	Preferred	Conservative
Egg, fish and meat	5.4%	6.4%	5.4%
Milk and milk products	4.6%	5.6%	4.6%
Cereals and products	2.0%	3.0%	0.8%
Pulses and products	4.9%	5.9%	4.9%
Vegetables and fruits	4.7%	5.7%	4.7%
Other	3.4%	4.4%	3.4%
Private Consumption, real	7.0%	7.0%	7.0%
Population growth	1.4%	1.4%	1.4%

<sup>15</sup> As in an inelastic supply system only price but not supply adjusts to equilibrate demand.

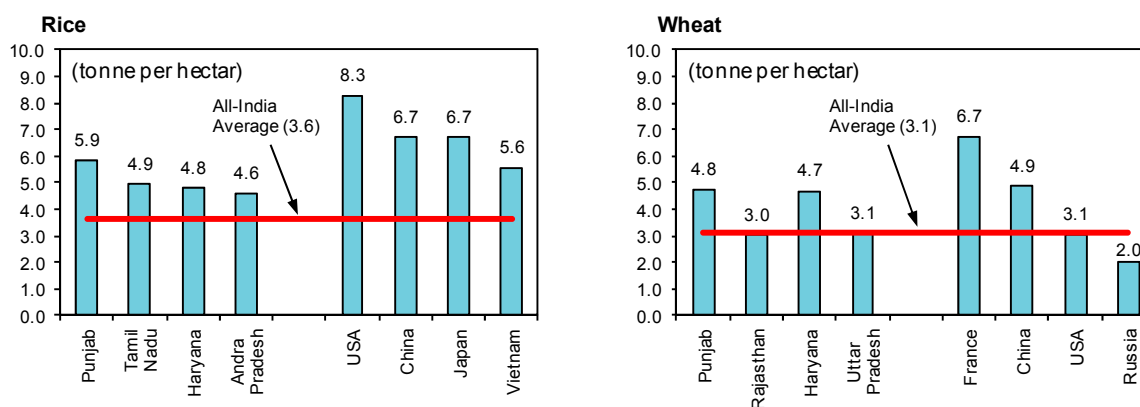
<sup>16</sup> <http://www.fapri.iastate.edu/tools/elasticity.aspx>

would exceed non-food inflation by 4 percentage points per year.

As well, taking into account historic food supply growth volatility<sup>17</sup> and absent a pro-active buffer stock policy, relative food inflation could contribute close to 1½ points to headline inflation over a two-year period. In turn, a pro active buffer stock intake and liquidation policy for cereals could help reduce the potential contribution of relative food inflation volatility by half over a two year period.

Our results thus imply that durably achieving a long-term inflation target of 4 percent under India’s recently adopted flexible inflation targeting framework will need policies to enhance food supply. For example, in the absence of increased food supply growth, average long-term non-food inflation would need to be brought down to around 2½ percent to achieve the target, which is low by historic and international experience and may be too costly in terms of growth and employment. In addition, the band of +/- 2 percent around the long-term inflation target of 4 percent appears appropriate, in light of relative food inflation volatility. It’s worth noting, that if the long-term average inflation was higher, the upper band would likely be breached more often, or would need a more aggressive monetary stance. Our analysis also suggests that administered price setting, such as through MSPs and supporting policies, constitute an important impediment to monetary policy transmission and will continue to pose challenges for monetary policy management in India. Finally, a pro-active buffer stock policy could be instrumental in containing inflation volatility and limiting the burden on monetary policy in addressing the adverse consequences of food supply shocks, including the second-round effects of transmission of food inflation shocks to core inflation.

**Figure 30. International and Indian State-Wise Productivity of Cereal Crops**



Note: yields for triennial periods, ending 2013-14 for rice, and 2012-13 for wheat.  
Source: Commission for Agricultural Costs and Prices, Ministry of Agriculture, Government of India.

<sup>17</sup> Increase in relative food inflation over two years in response to one standard deviation shock to domestic food supply.

## V. CONCLUSIONS AND POLICY IMPLICATIONS

Over the past decade, India has seen a prolonged period of high inflation, to a large extent driven by persistently-high food inflation. Domestic food demand and supply factors underpin India's food price dynamics. Relative food prices have played a key role in equilibrating India's food demand and domestic supply, given the limited responsiveness of agricultural production, particularly in the short run. The acceleration of India's economic growth witnessed during the last ten years, accompanied by stagnant agriculture growth, resulted in excess demand for food, giving rise to relative food price inflation. Furthermore, the excessive buffer stock build-up since 2007/08 and the lack of a pro-active liquidation policy increased average relative food inflation and its volatility.

As India's economic growth picks up, food demand pressures will remain strong, particularly for high-value foods, such as dairy products and animal-based proteins. Rising incomes will prompt shifts in food consumption away from simple starchy plant-dominated diets towards more nutritious and high-value foods that include a range of dairy products, vegetables and fruits, and meat.

Recent steps to contain food inflation will help in the short run, until more durable measures to increase food supply are put in place. The recent measures to limit the rise of minimum support prices for key agricultural commodities, wheat and rice in particular, the release of food grains from the Central Pool into the market, and adjustment of the buffers norms of these food grains to levels significantly below prevailing actual stocks, have helped lower cereal (rice and wheat) inflation. In addition, at the current juncture, the international commodity price outlook suggests that Indian cereal inflation is likely to remain benign.

Indian cereal yields are subpar in international comparison and the variation in yields across Indian states is also large (Figure 30). Therefore, price and income support (e.g. recent increase in MGNREGA working days for drought-affected rural areas) and stabilization policies would need to be complemented by policies to enhance agricultural productivity, including along the lines of the FCI Restructuring Committee Report. Going forward, excess demand will likely re-emerge, and thus a durable increase in supply, in particular through enhancing agricultural yields for key commodities, would be required to keep food inflation in check. The setting of MSPs should be guided by alignment of domestic and international prices along the long-term trends, while guarding against excessive domestic price volatility through temporary safeguards (CACP, 2014).

In the absence of a stronger food supply growth response, relative food inflation can contribute about 1¼ percentage points to headline inflation annually. Indian food inflation is likely to exceed non-food inflation by 2½–3 percentage points per year, assuming private consumption growth picks up to 7 percent per year and food supply grows at historic rates. Therefore, the sustainability of a long-term inflation target of 4 percent, under the recently-adopted flexible inflation targeting framework, will depend on enhancing food supply,

agricultural market-based pricing, and reducing price distortions. In the interim, monetary policy will need to remain tight to anchor inflation expectations at a lower level. As well, our simulation analysis indicates that in light of India's supply-side vulnerabilities, the band around the inflation target of +/- 2 percent is broadly appropriate. A well-designed cereal buffer stock liquidation policy could also help mitigate food inflation volatility. Finally, administered price setting, such as through MSPs and supporting policies, will continue to pose challenges for monetary policy management in India, as has been highlighted in the Patel Committee Report (RBI, 2014a).

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## APPENDIX

Table A1. Regression analysis of total food demand: first budgeting stage

Dependent variable: Food expenditure weight	All households
$\alpha_f$	0.9147661 *** (0.0139673)
$\gamma_{f,f}$	0.0040952 ** (0.0019713)
$\beta_f$	-0.1710632 *** (0.0030094)
$\lambda_f$	0.0035315 *** (0.0002866)
$\alpha_0$	-0.3615261 *** (0.0871973)
Number of observations	138,055

Source: IMF staff estimates.

Note: Robust standard errors in parenthesis.

Note: \*\*\*, \*\*, \* indicates 1, 5, 10 percent statistical significance.

Table A2. Regression analysis of food demand: second budgeting stage

Dependent variable: specific food category expenditure weights within total expenditure on food 1/			
$\alpha_1$	0.0088237 (0.0105971)	$\beta_1$	-0.0906848 *** (0.0056052)
$\alpha_2$	0.7792011 *** (0.00788)	$\beta_2$	0.2985137 *** (0.0037655)
$\alpha_3$	0.0045011 (0.086211)	$\beta_3$	-0.1362998 *** (0.0049977)
$\alpha_4$	0.0335076 *** (0.0041138)	$\beta_4$	0.0004809 (0.0023344)
$\alpha_5$	0.0460594 *** (0.0084452)	$\beta_5$	-0.0685883 *** (0.0045569)
$\gamma_{1,1}$	0.0508396 *** (0.0014078)	$\gamma_{3,3}$	0.0509947 *** (0.002251)
$\gamma_{1,2}$	-0.0362661 *** (0.0025156)	$\gamma_{3,4}$	-0.0012684 ** (0.0005724)
$\gamma_{1,3}$	0.0130379 *** (0.0011217)	$\gamma_{3,5}$	0.0045374 *** (0.0010383)
$\gamma_{1,4}$	-0.0070304 *** (0.000379)	$\gamma_{4,4}$	0.0173077 *** (0.0003484)
$\gamma_{1,5}$	-0.0119021 *** (0.0007133)	$\gamma_{4,5}$	-0.0032853 *** (0.0003766)
$\gamma_{2,2}$	0.1561513 *** (0.0033231)	$\gamma_{5,5}$	0.0433831 *** (0.0012753)
$\gamma_{2,3}$	-0.0676573 *** (0.002574)	$\lambda_1$	-0.0172765 *** (0.0007423)
$\gamma_{2,4}$	-0.0105381 *** (0.0010885)	$\lambda_2$	0.0355227 *** (0.0004995)
$\gamma_{2,5}$	-0.0331631 *** (0.0022921)	$\lambda_3$	-0.0147488 *** (0.000792)
$\lambda_4$	0.00311 *** (0.0003492)	$\lambda_5$	-0.0098896 *** (0.0006421)
Backed-out remaining QAIDS coefficients:			
$\alpha_6$	0.1279071 *** (0.0058365)	$\beta_6$	-0.0034218 (0.0033796)
$\gamma_{1,6}$	-0.0086787 *** (0.0005484)	$\gamma_{2,6}$	-0.0085266 *** (0.0001568)
$\gamma_{3,6}$	0.0003557 (0.0008364)	$\gamma_{4,6}$	0.0048146 *** (0.0003004)
$\gamma_{5,6}$	0.0004301 (0.0005029)	$\gamma_{6,6}$	0.0116050 *** (0.0004804)
$\lambda_6$	0.0032823 *** (0.0005151)		
Additional coefficient restrictions:			
$\gamma_{2,1} = \gamma_{1,2},$	$\gamma_{3,1} = \gamma_{1,3},$	$\gamma_{3,2} = \gamma_{2,3},$	$\gamma_{4,1} = \gamma_{1,4},$
$\gamma_{5,1} = \gamma_{1,5},$	$\gamma_{5,2} = \gamma_{2,5},$	$\gamma_{5,3} = \gamma_{3,5},$	$\gamma_{5,4} = \gamma_{4,5},$
$\gamma_{6,1} = \gamma_{1,6},$	$\gamma_{6,2} = \gamma_{2,6},$	$\gamma_{6,3} = \gamma_{3,6},$	$\gamma_{6,4} = \gamma_{4,6},$
			$\gamma_{6,5} = \gamma_{5,6},$
$R^2: w_1$	0.77	$R^2: w_2$	0.77
$R^2: w_3$	0.90	$R^2: w_4$	0.87
$R^2: w_5$	0.91		

Source: IMF staff estimates.

Note: Robust standard errors in parenthesis.

Note: \*\*\*, \*\*, \* indicates 1, 5, 10 percent statistical significance.

1/ Subscripts denote the following food categories: 1= "milk and products", 2="egg, fish and meat", 3="cereals and products", 4="pulsus and products", 5= "vegetables and fruits", 6 = "other (oils and fats, sugar, condiments and spices)".