Note to Readers

This is an excerpt from *Taming Indian Inflation*.

High and persistent inflation has been a serious macroeconomic challenge for India, particularly in the past decade. India’s high rates of inflation have been underpinned chiefly by high and persistent rates of food price inflation, which cascade quickly into rural and urban wages and into nonfood inflation.

This book takes a timely and in-depth look at the high and persistent inflation that has presented serious macroeconomic challenges to India in recent years—a situation that has helped to increase the country’s domestic and external vulnerabilities. The authors analyze various facets of Indian inflation and their implications for the Indian economy. Several chapters examine food inflation, given the very important role of food inflation in driving overall inflation dynamics in India. Building on this analysis of inflation dynamics, other chapters discuss the role of monetary policy in taming inflation. The book draws on the ongoing dialogue between the IMF staff and Indian authorities within the Reserve Bank of India and the Ministry of Finance.

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# Table of Contents

Foreword v  
Preface vii  

## PART I  CAUSES OF INFLATION

1 | Inflation Dynamics in India: What Can We Learn from Phillips Curves? ........3  
   | Roberto F. Guimarães and Laura Papi  
2 | Reconsidering the Role of Food Prices in Inflation..............................23  
   | James P. Walsh  
3 | Food Inflation in India.............................................................................45  
   | Prachi Mishra and Devesh Roy  
4 | Understanding India’s Food Inflation Through the Lens of Demand and Supply..75  
   | Rahul Anand, Naresh Kumar, and Volodymyr Tulin  

## PART II  CONSEQUENCES OF INFLATION

5 | Does Inflation Slow Long-Run Growth in India?....................................115  
   | Kamiar Mohaddes and Mehdi Raissi  
6 | Inflation and Income Inequality: Is Food Inflation Different? .............131  
   | James P. Walsh and Jiangyan Yu  
7 | Transmission of India’s Inflation to Neighboring Countries ...............149  
   | Sonali Das, Adil Mohommad, and Yasuhisa Ojima  

## PART III  POLICIES TO AFFECT INFLATION

8 | Monetary Policy Transmission in India................................................169  
   | Sonali Das  
9 | Food Inflation in India: What Role for Monetary Policy?.....................187  
   | Rahul Anand and Volodymyr Tulin  
10 | Inflation and Monetary Policy in Small Open Economies...................201  
    | Paul Cashin and Agustín Roitman  

Contributors ...................................................................................................223  
Index .............................................................................................................227
Foreword

This book is a timely look at an important Indian macroeconomic issue—inflation. High and persistent inflation has been a serious macroeconomic challenge for India, particularly in the past decade. India’s high rates of inflation have been underpinned chiefly by high and persistent rates of food price inflation, which cascade quickly into rural and urban wages and into nonfood inflation. Well-entrenched inflation expectations have also been a key driver of India’s high inflation rates.

Over the past decade India has increasingly opened itself to the global economy and has become one of the world’s fastest-growing economies. As it seeks to sustain rapid growth and improve the welfare of its large and fast-growing population, India also needs to aim for greater price stability.

This book documents and analyzes India’s long-ongoing quest to bring inflation down. It grew out of the IMF staff’s ongoing policy dialogue with the Indian authorities, in particular at the Reserve Bank of India and the Ministry of Finance. The focus of several of the chapters evolved from the exchange of views with officials from these agencies, and with the many Indian academics interested in these issues.

The IMF is contributing to the advancement of the Indian economy through our ongoing policy dialogue, analytical work, and capacity building. I am sure this book will help in this effort and give due recognition to the authorities’ efforts directed at taming inflation to reduce poverty, raise domestic consumption and growth, and improve the welfare of over 1.2 billion Indian citizens.

Christine Lagarde
Managing Director
International Monetary Fund
High and persistent inflation has presented a serious macroeconomic challenge in India in recent years, increasing the country’s domestic and external vulnerabilities. For example, high inflation contributed to an historic widening of the current account deficit, exposing India to global financial market turbulence and slowing growth. As Reserve Bank of India Governor Raghuram Rajan pointed out at the 8th R. N. Kao Memorial Lecture in 2014, “inflation is a destructive disease … we can’t push inflation under the carpet as a central banker. We have to deal with it.”

A number of factors underpin India’s high rates of inflation, including food inflation feeding quickly into wages and core inflation; entrenched inflation expectations; cost-push shocks from binding sector-specific supply constraints (particularly in agriculture, energy, and transportation); pass-through from a weaker rupee; and ongoing energy price increases. This book analyzes various facets of Indian inflation and their implications for the conduct of monetary policy. Indeed, several chapters are devoted to analyzing and managing food inflation, given the very important role of food inflation in driving overall inflation dynamics in India. Building on this analysis of inflation dynamics, several chapters discuss the role of monetary policy in taming inflation, which is important for the country given the economic and social costs of its high and persistent inflation.

Using the Phillips curve framework, Roberto Guimarães and Laura Papi, in Chapter 1, find that inflation in India can be reasonably well modeled with standard Phillips curves, augmented with a measure of relative international commodity prices. They show that India’s inflation dynamics are explained by both backward- and forward-looking inflation components, and that the output gap, though empirically relevant, is not robust across model specifications. Evidence suggests that the effect of the output gap on inflation is larger at higher levels of inflation, but that inflation becomes more inertial at higher levels.

Because food inflation has played a key role in shaping the dynamics of inflation in India, and made monetary management more difficult, the next few chapters delve deeper into analyzing food inflation. It is widely believed that fluctuations in food and energy prices represent supply shocks, and as such are transitory, volatile, and nonmonetary in nature. For these reasons, food prices are generally excluded from the measures of inflation most closely watched by policymakers in advanced economies.

James Walsh, in Chapter 2, focuses on the role of food inflation in lower-income countries and emerging markets, and finds that food price inflation is not only more volatile in these economies, but also higher than nonfood inflation on average. Walsh shows that food inflation is in many cases more persistent than nonfood inflation, and that food price shocks in many countries propagate strongly into nonfood inflation. Under these conditions, a policy focus on
measures of core inflation that exclude food prices can misspecify inflation, leading to higher inflationary expectations, a downward bias to forecasts of future inflation, and lags in policy responses. In constructing measures of core inflation, policymakers should therefore not assume that excluding food price inflation will provide a clearer picture of underlying inflation trends than headline inflation.

Chapter 3, by Prachi Mishra and Devesh Roy, examines food inflation in India using a high-frequency, commodity-level data set spanning the past two decades. Documenting stylized facts about the behavior of food inflation, the authors explicitly quantify the contribution of specific commodities to food inflation in India. Their analysis suggests that animal source foods (milk, fish), processed food (sugar, edible oils), fruits and vegetables (for example, onions), and cereals (rice and wheat) have been the primary drivers of food price inflation. Insights from this analysis of overall food inflation, as well as individual case studies, are used to make specific policy recommendations for curbing inflation.

In Chapter 4, Rahul Anand, Naresh Kumar, and Volodymyr Tulin investigate the demand and supply factors behind the contribution of relative food inflation to general inflation. They find that India’s food inflation developments over the past decade appear to have largely reflected demand pressures (driven by strong private consumption growth), which have often outpaced supply of key food commodities. Their analysis suggests that in the absence of a stronger food supply growth response, food inflation may exceed nonfood inflation by 2½−3 percentage points per year. Given this, 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.

The next few chapters explore the costs of inflation in India—on both growth and inclusiveness—and document the spillovers of Indian inflation to the neighboring countries of Nepal and Bhutan. In Chapter 5, Kamiar Mohaddes and Mehdi Raissi examine the long-term relationship between the consumer price index for industrial workers (CPI-IW) inflation and GDP growth in India. Using a sample of 14 Indian states over 1989–2013, the chapter’s findings suggest that, on average, there is a negative long-term relationship between inflation and economic growth. The authors find there is a statistically significant inflation-growth threshold effect in states with persistently elevated consumer price index inflation rates of over 5½ percent. These findings suggest that the Reserve Bank of India needs to balance the short-term growth-inflation trade-off, in light of the long-term negative effects on growth of persistently high inflation.

In Chapter 6, James Walsh and Jiangyan Yu analyze the effects of inflation on income inequality, and find these can be differentiated by the type of inflation. Higher nonfood inflation is strongly associated with greater income inequality, but food inflation has more mixed effects. Across a sample of Indian states, nonfood inflation is associated with worsening income inequality in both urban and rural areas. On the other hand, higher food inflation has an ambiguous
relationship with income inequality in urban areas, but is strongly associated with lower income inequality in rural areas.

Sonali Das, Adil Mohammad, and Yasuhisa Ojima, in Chapter 7, explore the spillovers of Indian inflation—particularly food inflation—on Nepal and Bhutan. Inflation dynamics in both countries are closely linked to those in India, given their exchange rate pegs to the Indian rupee. The authors suggest that food inflation in Nepal, a key driver of the country’s headline inflation, is highly correlated with food price changes in India. Similarly, headline inflation in Bhutan over the past three decades shows a tendency to comove with India’s headline CPI inflation rate. Given their exchange rate regimes and close trade ties with India, it is unlikely that inflation will be delinked from India in the near term.

Against a backdrop of the high cost of inflation and spillovers to neighboring countries, Chapters 8 and 9 discuss the role of monetary policy in taming India’s high and persistent inflation. Sonali Das, in Chapter 8, evaluates the effectiveness of the credit channel of monetary policy transmission. Using stepwise estimation of vector error correction models, she finds significant, albeit slow, pass-through of policy rate changes to bank interest rates, and evidence of asymmetric adjustment to monetary policy. Here, bank lending rates adjust more quickly to monetary tightening than to loosening. Moreover, the speed of adjustment of bank deposit and lending rates to changes in the policy rate has increased in recent years.

In Chapter 9, Rahul Anand and Volodymyr Tulin discuss the role of monetary policy in combating food inflation in India, as this has presented challenges for monetary management. It is a widely held view that central banks should only respond to changes in underlying core inflation and to any second-round effects on core inflation of commodity price shocks. This chapter estimates the size of these second-round effects and finds particularly large effects in India. The results also indicate that India’s inflation is highly inertial and persistent. The authors’ analysis suggests that to durably reduce India’s relatively high rates of inflation, the monetary policy stance needs to remain tight for a considerable length of time.

Paul Cashin and Agustín Roitman, in Chapter 10, examine the role of optimal monetary policy in the presence of large and persistent supply shocks. They show that responding to headline inflation is welfare superior to responding to core inflation, and that this often proves to be a more effective response in containing overall inflation, as well as in mitigating consumption and output fluctuations. Moreover, having a clear, easy-to-understand, and transparent rule can help with the formation of accurate and realistic inflation expectations, and serve as an effective nominal anchor in the face of international commodity price fluctuations. Implementing such a rule is also useful to build and enhance the credibility of the monetary authority, and thereby increase the effectiveness of monetary policy in seeking to achieve and maintain price stability.
CHAPTER 4

Understanding India’s Food Inflation Through the Lens of Demand and Supply

RAHUL ANAND, NARESH KUMAR, AND VOLODYMYR TULIN

Food inflation in India, unlike in many advanced economies, has had a nontrivial impact on aggregate retail inflation. This reflects, among other things, the large share of food expenditure in total household expenditure and its correspondingly heavy weight in the consumer price index (CPI), inflation expectations which are anchored by food inflation, and 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 of large second-round effects of food price shocks, has been documented (Anand, Ding, and Tulin 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 nonmonetary policies—notably the role of minimum support prices and the Mahatma Gandhi National Rural Employment Guarantee Act—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 other than raising supply rapidly. Although many studies have investigated demand and supply of the major food commodities in India and projected demand and supply scenarios, even at the commodity level, analysis of food prices in an equilibrating demand-supply framework is practically nonexistent.

This chapter explores the relative role of demand and supply factors and quantifies their impact on the dynamics of food prices in India in a general equilibrium setting. To do this, we adopt a two-stage strategy. First, we estimate individual demand for major food product groups and examine key household consumption patterns using household expenditure surveys. We then construct a general equilibrium model for given output growth scenarios, allowing us to estimate the impact of demand-side pressure on relative food prices. Using this model, we estimate the size of relative food prices since 2006 and simulate possible scenarios.

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1 See Ganesh-Kumar and others (2012) for literature review, as well as for medium-term forecasts on India’s demand and supply gaps for food grains.
of the contribution of relative food inflation in the medium term. For scenario analysis, the approach of abstracting away from explicit modeling of food supply is not without limitations, 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 response of supply, particularly over the near term.

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

Our estimates suggest that in the absence of a stronger food supply growth response, relative food inflation can contribute about 1¼ percentage points to headline inflation annually. If private consumption picks up to 7 percent and supply growth response remains at its historical level, food inflation is likely to exceed nonfood inflation by 2½–3 percentage points per year. Monetary policy will therefore need to react appropriately to both supply shocks and underlying inflation trends, particularly in the context of the flexible inflation targeting adopted in February 2015. Achieving a long-term inflation target of 4 percent will hinge on enhancing food supply, market-based pricing of agricultural produce, and reducing price distortions. Our simulation analysis also indicates that given India’s supply-side vulnerabilities, the recommended inflation band of ±2 percent appears broadly appropriate. A well-designed cereal buffer stock liquidation policy could help mitigate inflation volatility. In addition, administered price setting, such as through minimum support prices and supporting policies, will continue to pose challenges for monetary policy management in India. At the current juncture when relative food prices do not appear to be a key driver of headline inflation, ensuring a durable reduction in headline inflation will require the continuation of a relatively tight monetary stance to durably lower core inflation so as to sustainably reduce inflation expectations and anchor them at a lower level.

**RECENT INFLATION DYNAMICS IN INDIA**

High and persistent inflation has been a key macroeconomic challenge facing India (IMF 2014a, 2014b; Anand, Ding, and Tulin 2014). Elevated inflation coinciding with the growth slowdown has distinguished India from other major emerging market economies in recent years. Though several reasons have been

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2 As in an inelastic supply system, only price but not supply adjusts to equilibrate demand.
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 4.1). Furthermore, through its second-round effects on core inflation (Anand, Ding, and Tulin 2014), food inflation has added to the inflationary pressure.

INDIA’S FOOD INFLATION: A TIMELINE

A chronological account of India’s food inflation reveals several important events, which have been widely documented and researched (Gokarn 2011; Sonna and others 2014):

- A set of policy interventions commonly known as the Green Revolution caused food inflation episodes to be short-lived and less intense during the 1980s and 1990s. These interventions combined price incentives, input subsidies, technological inputs and infrastructure investments (particularly in irrigation), and, importantly, buffer stocks. The policy interventions helped to raise and stabilize the productivity of cereal cultivation, as well as some other crops (Gokarn 2011).
However, during the 1990s and 2000s, agricultural growth slowed, averaging about 3.5 percent per year. Cereal yields grew by only 1½ percent per year in the 2000s. Amid firming consumer demand, running down buffer stocks helped contain food inflation during the early 2000s, as increases in minimum support prices moderated (Figure 4.2).

The government’s response, beginning in 2007, to a surge in global food prices helped limit the impact on domestic food prices (OECD 2009). However, buffer stocks continued to fall, eventually to significantly below established 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 an increase of more than 30 percent in minimum

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**Figure 4.2. Policy Interventions and Outcomes: Buffer Stocks of Rice and Wheat**

1. Rice: buffer norms and actual stock in Central Pool  
   *(Million metric tonnes, as of January 1)*

2. Wheat: buffer norms and actual stock in Central Pool  
   *(Million metric tonnes, as of January 1)*

3. Rice: minimum support and actual prices  
   *(Annual percent change, on crop-year basis)*

4. Wheat: minimum support and actual prices  
   *(Annual percent change, on crop-year basis)*

Sources: Food Corporation of India; and IMF staff calculations.
Note: In panels 3 and 4, crop year denotes a 12-month period from July through next June.  
MSP = minimum support price; WPI = wholesale price index.
support prices for the 2008/09 season—likely not only postponed, but also prolonged inflationary pressures even after global food commodity prices abated (Figure 4.3). The global commodity price spike of 2007–08 also led to excessive stock hoarding in subsequent years, a shift in the buffer stock policy resulting in sustained inflationary pressure (Figure 4.2).³

- Deficient rainfall, as a result of weaker monsoon in 2009, affected the 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 nonfood inflation by almost 30 percentage points during 2006–10: food inflation exceeded nonfood inflation on an average by almost 7½ percentage points per year during this period (Figure 4.3).

- Even though 2010 was 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. This time, nonfood inflation also picked up, averaging 9½ percent during 2010–13, a full 3 percentage points higher than the average of 6½ percent 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 (Figure 4.4). This accelerated the inflationary spiral with food inflation feeding quickly into wages and core inflation (Figure 4.5).

³In the aftermath of the surge in global commodity prices, not only food importers but also the largest exporters, namely China and India, became wary of overreliance on international grain markets, particularly in times of food emergency, which led to large-scale grain procurement and hoarding.
Figure 4.4. India: Food versus Nonfood Inflation
(Index, 2006 = 100)

Sources: Haver Analytics; and IMF staff calculations.
Note: Monthly data; CPI = consumer price index.

Figure 4.5. Food Inflation and Household Inflation Expectations
(Percent)

Source: Reserve Bank of India.
INDIA’S FOOD INFLATION: THE SUPPLY-DEMAND ANGLE

While a number of supply-side factors could be responsible for 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 from a 5 percent average growth rate during 1998/99–2004/05 (Figure 4.6). Moreover, private consumption growth was essentially unaffected by the global financial crisis. However, following a slowdown in the economy, private consumption growth declined in 2012/13 and 2013/14; demand-side pressures on food inflation were thereby reduced.

Agricultural GDP growth remained robust during 2005/06–2007/08, growing at about 5 percent per year (Figure 4.7). 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 (see Figure 4.4). During these three years, food inflation accelerated significantly. For example, wholesale price index (WPI) food inflation jumped to about 8¾ percent per year from an average

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4 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.
of 1¾ percent during 2000/01–2004/05. Furthermore, the surge in relative food prices continued during 2008/09–2009/10. Even though private consumption growth moderated due to the global financial crisis, 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.

As a result of a good monsoon, agricultural GDP growth recovered in 2010/11 and 2011/12 to 8½ and 5 percent, respectively (Figure 4.7). Simultaneously, with a concurrent moderation in private consumption growth due to the economic slowdown, relative food prices remained broadly stable during this period. At the same time, however, nonfood inflation was high and remained firm in the 9–10 percent range, partly as a result of an accommodative monetary stance resulting from a delayed withdrawal of stimulus provided during the global financial crisis (Anand, Ding, and Tulin 2014; Mohan and Kapur 2015).

**INDIA’S FOOD INFLATION: A RESULT OF LOOSE MONETARY POLICY**

While monetary policy in India was suitably eased to counter the global financial crisis, the subsequent tightening that began in 2010 was not sufficient to rein in inflation, which had become generalized by then. As suggested by Anand, Ding, and Tulin (2014), the short-term interest rate gap vis-à-vis its optimal level, a gauge of the monetary stance, averaged about 100 basis points during 2011–12
Successive IMF India Staff Reports highlighted the role of an overly accommodative monetary stance in fostering persistently high inflation, which argued for a tighter monetary stance to counter inflation and inflationary pressures (IMF 2011, 2012, 2013, 2014a, 2014b). Concerns over insufficient tightening were also raised in India.5

**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 that incorporates India’s household surveys. We then model the supply of these food item groups, and use a general equilibrium framework to analyze the interaction of demand and supply in determining food prices in India.

As highlighted in the previous section, growing income per capita 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).

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5As, for example, noted by Chakravarthi 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 have had a better impact on inflation.”
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, they decide on spending across broad categories of goods or services—our model entails a choice between food and nonfood. Each consumer decides on how much to spend on food items and nonfood items. In the second step, each consumer 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. We look at six food item groups: cereals; pulses; milk; egg, fish and meat; vegetables and fruits; and a category that includes oil and fats, sugar, condiments, and spices.

The two-stage approach invokes the block independence idea or strong group-separability assumption of the 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 nonfood items is not influenced by demand decisions for specific food items. A simple first-stage budgeting, which involves a choice between only two broad expenditure groups (namely, food and nonfood), allows us to greatly simplify the econometric estimation. The added condition of the expenditure weights—that the budget share on food and nonfood 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 complements 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 nonfood 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, Blundell, and Lewbel 1997). QUAIDS is an extension of the almost ideal demand system (AIDS) approach (Deaton and Muellbauer 1980) that includes a quadratic expenditure term to model nonlinearity of Engel curves. In the literature, 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 those in India (Mittal 2010).

The first stage of QUAIDS involves estimating a first-step budgeting equation, whereby consumers make a choice about how much total expenditure will be devoted to food, conditional on the consumption of nonfood goods and services, and the demographic and socioeconomic characteristics of households. The non-linearity in food expenditure—implying that a 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—food and nonfood—the adding-up restriction on the expenditure weights implies that the first-stage estimation is reduced to a single equation least squares estimation. See Annex 4.1 for additional details.

In the second stage, we estimate a system of simultaneous equations, each representing demand for specific food item categories (cereals; pulses; milk; egg, fish, and meat; vegetables and fruits; and others). Here, we specify a QUAIDS system of individual food item demand equations (see for example, Poi 2002, 2008) using the general QUAIDS structure outlined in Box 4.1, where expenditure weights represent expenditure on specific food categories as a share of the 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 nonlinear, seemingly unrelated regressions through iterated feasible generalized least squares, using the Stata routine described in Poi (2008).

Supply Analysis

The consumer demand model we use for estimation and simulation purposes assumes that prices, food prices in particular, are predetermined. The 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 the markets. 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, studies of the 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

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6 Inelastic supply assumptions are usually more suitable to analyze demand for goods with fixed prices, as a result of administered price setting.
Understanding India's Food Inflation Through the Lens of Demand and Supply

BOX 4.1 General QUAIDS Specification

In the quadratic almost ideal demand system (QUAIDS) model, a consumer’s expenditure shares across the set of expenditure categories are defined by equations 1 and 2:

\[ w_{i,j} = \frac{p_{i,j} q_{i,j}}{m_i} \]  
\[ \sum_{j=1}^{N} w_{i,j} = 1 \]

where \( p_{i,j} \) and \( q_{i,j} \) are price and quantity of item \( j \) purchased or consumed by an individual \( i \), and \( w_{i,j} \) is expenditure weight on item \( j \) in individual \( i \)'s total expenditure (denoted by \( m_i \)) across all related products \( j = 1, N \). In the first stage of the consumer budgeting choice, \( w_{i,j} \) refers to the shares of expenditure on food versus nonfood categories as a part of the 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:

\[ w_{i,j} = \alpha_j + \sum_{n=1}^{N} \gamma_{j,n} \ln p_{i,n} + \beta_j \ln \frac{m_i}{P(p_i)} + \frac{\lambda_j}{b(p_i)} \left[ \ln \frac{m_i}{P(p_i)} \right]^2 + \theta_{i,j} \]  

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

\[ b(p_i) = \prod_{j=1}^{N} p_{i,j}^{\beta_j} \]

In \( P(p_i) \) is a price index defined as:

\[ \ln P(p_i) = \alpha_0 + \sum_{n=1}^{N} \alpha_n \ln p_{i,n} + \frac{1}{2} \sum_{j=1}^{N} \sum_{n=1}^{N} \gamma_{j,n} \ln p_{i,j} \ln p_{i,n} \]

Note that the term \( \frac{m_i}{P(p_i)} \) essentially represents a measure of an individual’s real consumption. The quadratic term for the logarithm of consumption allows us to capture the nonlinearity of consumption of specific product categories with respect to total expenditure on related products. \( \theta_{i,j} \) denotes a residual term, with the vector of residuals \( \theta = [\theta_1, \ldots, \theta_N] \) 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:

\[ \sum_{j=1}^{N} \alpha_j = 1, \sum_{j=1}^{N} \beta_j = 0, \sum_{j=1}^{N} \lambda_j = 0, \text{ and } \sum_{j=1}^{N} \gamma_{j,n} = 0 \quad \forall n \]

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

1. Demand function homogeneity of degree zero in prices and income requires:

\[ \sum_{j=1}^{N} \gamma_{j,n} = 0 \quad \forall j \]
(2) whereas Slutsky symmetry implies:

$$\gamma_{ij} = \gamma_{ij}$$

In the first stage, we estimate the aggregate food demand equation compared to total expenditure on nonfood categories. As mentioned, 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 QUAIDS specification (3) can be reduced to the following food demand equation, which can be estimated using least squares:

$$\frac{m_f'}{Y} = \alpha_f + \gamma_{ij} \left( \ln P_f' - \ln P_{nf}' \right) + \beta_f \ln \left( \frac{Y_f}{P_f} \right) + \frac{\lambda_f}{b(P)} \left( \ln \frac{Y_f}{P_f} \right)^2 + \epsilon_i$$

where consumer-specific aggregate price indexes $b(P_i)$ and $P(P_i)$ are defined according to equations 4 and 5, which after imposing the mentioned coefficient restrictions, reduce to:

$$\ln b(P_i) = \beta_f \left( \ln P_f' - \ln P_{nf}' \right)$$

$$\ln P(P_i) = \alpha_f + \gamma_{ij} \left( \ln P_f' - \ln P_{nf}' \right) + P_f' + \frac{1}{2} \gamma_{ij} \left( \ln P_f' - \ln P_{nf}' \right)^2$$

where $m'$ denotes total per capita expenditure on food; $P_f$ and $P_{nf}$ represent consumer-specific aggregate price index of food and nonfood items, respectively; $Y$ is per capita total consumption expenditure; and $\epsilon$ is an error term.

Substituting aggregate price indexes specifications given by equations 10 and 11 into equation 9, we estimate the resulting food demand function using nonlinear least squares using 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 nonfood price $P_{nf}$ indexes are approximated using Stone price indexes:

$$\ln P_i = \sum_{j=1}^{N} w_{i,j} \ln P_{i,j}$$

1 Stone’s (geometric) price index is a common price index approximation based on a linear approximate AIDS following Blancforti and Green (1983).

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 general equilibrium dynamics assuming inelastic supply curves (that is, supply remains constant in the short term).
RESULTS AND DISCUSSION

Household Demand for Food

Results of the regression analysis are reported in Annex 4.1, and Box 4.2 explains how to interpret these coefficients.

We focus on six food categories representing key food groups in the Indian household consumption basket: milk and milk products; egg, fish, and meat; pulses; cereals; vegetables and fruits; and a category of other foods that includes oil and fats, sugar, condiments, and spices. The choice of these categories is driven by distinct government policies, such as those 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 and in the household survey data. Estimated expenditure weights on key food categories in the latest household survey (National Sample Survey Office 68th round for 2011/12) closely track weights in CPI Combined (Table 4.1), supporting the suitability of household-survey-based analysis to study implications of food demand dynamics for CPI inflation in India.

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 patterns across the income spectrum of Indian households.

The estimates suggest that as income per capita goes up by 1 percent, the demand for food rises by 0.64 percent (Table 4.2). Similarly, a 1 percent increase in food prices results in a 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 the same level of welfare, the total expenditure on food goes down by 0.35 percent when food prices rise by 1 percent.

Panel 1 of Figure 4.9 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). Panel 2 suggests that households spending a lot on food (high weight on food expenditure) also have high income elasticity of food expenditure. Panels 1 and 2 together suggest that the demand for food by poorer households goes up by more than for richer households when income per capita rises. Panels 3 and 4 of Figure 4.9 present price elasticities of food for food expenditure weights. The results suggest that the elasticity is relatively large for those who spend a lot on food.

Note that CPI expenditure categories, commonly attributed to the food basket, such as beverages (2 percent CPI weight), prepared meals (2.8 percent), and pan, tobacco, and intoxicants (2.1 percent), are excluded from the analysis.
The quadratic almost ideal demand system (QUAIDS) coefficients are usually interpreted following basic transformation of the estimated raw coefficients of equation 3 in Box 4.1. Specifically, following Banks, Blundell, and Lewbel (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 (μ_\text{j} and μ_{jn} respectively) can be calculated using expressions 13–15:

\[ \mu_j = \frac{\partial w_j}{\partial \ln m} = \beta_j + \frac{2\lambda_j}{b(p)} \ln \frac{m}{p(p)} \]  

\[ \mu_{jn} = \frac{\partial w_j}{\partial \ln p_k} = \gamma_{jn} - \mu_j \left( \alpha_n + \sum_{k=1}^{N} \gamma_{jn} \ln P_k \right) - \frac{\lambda_j \beta_n}{b(p)} \left( \ln \frac{m}{p(p)} \right)^2 \]  

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

\[ e_j = \frac{\mu_j}{w_j} + 1 \]  

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 understanding India's future food demand, equation 15 allows us to understand how demand for food, as well for specific food items, is likely to evolve with India's overall economic development. 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 above 1; inferior goods have negative elasticities.

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

\[ e^M_{jn} = \frac{\mu_{jn}}{w_j} - d_{jn} \]  

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

\[ e^H_{jn} = e^M_{jn} + e_j w_j \]
Understanding India’s Food Inflation Through the Lens of Demand and Supply

Second-Stage Budgeting Estimation Results: Expenditure on Specific Food Categories

Using expenditure weights for specific food categories and individual total food expenditure, we now 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 for total food expenditure, we can essentially classify the six food categories into three groups (Table 4.3):

- **High income elasticity products**—Includes milk products as well as egg, fish, and meat. On average, expenditure on these items (across all households) will increase disproportionally more than the increase in total food expenditure.
- **Unit income elasticity products**—Includes vegetables and fruits. On average, expenditure on these items (across all households) will rise at the same rate as the increase in total food expenditure.

### TABLE 4.1
Food Expenditure Weights in CPI-Combined and Household Survey Data (Percent of total household expenditure)

<table>
<thead>
<tr>
<th>Food Category</th>
<th>CPI Combined</th>
<th>Household Survey (NSSO 68th Round)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg, fish, and meat</td>
<td>2.9</td>
<td>3.5</td>
</tr>
<tr>
<td>Milk and milk products</td>
<td>7.73</td>
<td>8.4</td>
</tr>
<tr>
<td>Cereals and cereal products</td>
<td>14.6</td>
<td>12.9</td>
</tr>
<tr>
<td>Pulses and pulse products</td>
<td>2.7</td>
<td>3.4</td>
</tr>
<tr>
<td>Vegetables and fruits</td>
<td>7.3</td>
<td>6.9</td>
</tr>
<tr>
<td>Other (oils and fats, sugar, condiments, and spices)</td>
<td>7.5</td>
<td>8.1</td>
</tr>
</tbody>
</table>

Sources: Haver Analytics; and IMF staff estimates.
Note: Expenditure on nonalcoholic beverages, pan, tobacco and intoxicants, and prepared meals not included.

CPI = consumer price index; NSSO = National Sample Survey Office.

### TABLE 4.2
Food Demand Elasticities: First Budgeting Stage (Sample mean values)

<table>
<thead>
<tr>
<th>Income Elasticity of Total Food Expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.640</td>
</tr>
<tr>
<td>(0.172)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Uncompensated (Marshalian) Price Elasticity of Total Food Expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food prices</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>–0.627</td>
</tr>
<tr>
<td>(0.185)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Compensated (Hicksian) Price Elasticity of Total Food Expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food prices</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>–0.353</td>
</tr>
<tr>
<td>(0.086)</td>
</tr>
</tbody>
</table>

Source: IMF staff estimates.
Note: Standard deviations relative to sample mean values in parenthesis.
Figure 4.9. Analysis of Household Total Food Expenditure

1. Fitted Engel curve for food

2. Food budget share elasticity

3. Compensated food price elasticity

4. Uncompensated food price elasticity

TABLE 4.3

<table>
<thead>
<tr>
<th>Food Category</th>
<th>Expenditure Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg, fish, and meat</td>
<td>1.321</td>
</tr>
<tr>
<td>Milk and milk products</td>
<td>1.590</td>
</tr>
<tr>
<td>Cereals and cereal products</td>
<td>0.848</td>
</tr>
<tr>
<td>Pulses and pulse products</td>
<td>0.666</td>
</tr>
<tr>
<td>Vegetables and fruits</td>
<td>1.000</td>
</tr>
<tr>
<td>Other (oils and fats, sugar, condiments, and spices)</td>
<td>0.841</td>
</tr>
</tbody>
</table>

Source: IMF staff estimates.

Note: Table shows expenditure elasticity for a given food category with respect to total expenditure on food.

- **Less-than-unity income elasticity products**—Includes pulses, cereals, and the “other products” category. On average, 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 Bennet’s law, which states that with rising incomes, food consumption shifts from simple starchy plant–dominated diets toward more nutritious and high-value foods that include dairy products, vegetables and fruits, and especially meat.
The estimates of expenditure elasticities reported in Table 4.3 correspond to their mean values across all households, and thus do not take into account differences in food budgets across households. To gain an insight into the possible impact of increased food expenditure on the aggregate demand for specific food categories, and 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 4.4 are qualitatively similar, though magnitudes are closer to unity, suggesting that aggregate demand impact for high-elasticity food commodities is somewhat lower than the simple mean elasticity estimates.

Note that in the aggregated expenditure elasticity analysis, we focus 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 for increases in total household expenditure. This assumes a uniform percent change in total household expenditure and then accounts for the impact of the interaction of its variation with the variation in total household food expenditure elasticity on each household’s total food expenditure, and then on expenditure on specific food items. The results in Table 4.5 indicate a significantly higher increase

### Table 4.4

<table>
<thead>
<tr>
<th>Food Category</th>
<th>Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg, fish, and meat</td>
<td>1.165</td>
</tr>
<tr>
<td>Milk and milk products</td>
<td>1.326</td>
</tr>
<tr>
<td>Cereals and cereal products</td>
<td>0.845</td>
</tr>
<tr>
<td>Pulses and pulse products</td>
<td>0.725</td>
</tr>
<tr>
<td>Vegetables and fruits</td>
<td>0.985</td>
</tr>
<tr>
<td>Other (oils and fats, sugar, condiments, and spices)</td>
<td>0.848</td>
</tr>
</tbody>
</table>

Source: IMF staff estimates.

Note: Table shows expenditure elasticity for a given food category with respect to total expenditure on food.

### Table 4.5

<table>
<thead>
<tr>
<th>Food Category</th>
<th>Relative to Pulses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg, fish, and meat</td>
<td>0.592</td>
</tr>
<tr>
<td>Milk and milk products</td>
<td>0.645</td>
</tr>
<tr>
<td>Cereals and cereal products</td>
<td>0.468</td>
</tr>
<tr>
<td>Pulses and pulse products</td>
<td>0.391</td>
</tr>
<tr>
<td>Vegetables and fruits</td>
<td>0.484</td>
</tr>
<tr>
<td>Other (oils and fats, sugar, condiments, and spices)</td>
<td>0.459</td>
</tr>
</tbody>
</table>

Source: IMF staff estimates.

Note: Table shows expenditure elasticity for a given food category with respect to total household expenditure.
in demand for milk and milk products and the category of egg, fish, and meat 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 household incomes grow.

Own-price uncompensated demand elasticities reported in Table 4.6 provide some insight into the extent of sensitivity of demand for specific food items to prices. Specifically, holding total household food expenditure constant, demand for milk and related products is least sensitive to changes in milk prices, while the demand for other proteins (in the categories egg, fish, and 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. The uncompensated cross-price elasticities reported in Table 4.6 indicate some complementarity among most food categories. For example, a 1 percent increase in the price of egg, 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; egg, fish, and meat; and also pulses. In other words, when prices of proteins rise while food budgets stay unchanged, consumption is switched to cereals and related products (see also Figure 4.10).

Hicksian price elasticities provide a somewhat different insight into food demand patterns in India. Most of the food categories emerge as substitutes (Table 4.7). 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 risen. Perhaps the only food category that is a noticeable exception is vegetables and fruits with respect to their sensitivity to prices of egg, fish, and meat. As prices of this category of food rise, the demand for vegetables and fruits needs to decline, in part as consumers substitute egg, fish, and meat for other proteins, namely pulses and milk.

### Table 4.6

<table>
<thead>
<tr>
<th>Food Category</th>
<th>Egg, Fish, and Meat</th>
<th>Milk and Milk Products</th>
<th>Cereals and Cereal Products</th>
<th>Pulses and Pulse Products</th>
<th>Vegetables and Fruits</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg, fish, and meat</td>
<td>-0.563</td>
<td>-0.026</td>
<td>-0.044</td>
<td>-0.134</td>
<td>-0.169</td>
<td>-0.080</td>
</tr>
<tr>
<td>Milk and milk products</td>
<td>-0.096</td>
<td>-0.880</td>
<td>-0.102</td>
<td>-0.216</td>
<td>-0.091</td>
<td>-0.089</td>
</tr>
<tr>
<td>Cereals and cereal products</td>
<td>0.020</td>
<td>0.013</td>
<td>-0.858</td>
<td>0.008</td>
<td>-0.017</td>
<td>0.028</td>
</tr>
<tr>
<td>Pulses and pulse products</td>
<td>-0.045</td>
<td>-0.068</td>
<td>0.015</td>
<td>-0.704</td>
<td>0.002</td>
<td>0.047</td>
</tr>
<tr>
<td>Vegetables and fruits</td>
<td>-0.254</td>
<td>-0.028</td>
<td>-0.035</td>
<td>-0.052</td>
<td>-0.754</td>
<td>0.001</td>
</tr>
<tr>
<td>Other</td>
<td>-0.062</td>
<td>-0.012</td>
<td>0.024</td>
<td>0.098</td>
<td>0.030</td>
<td>-0.907</td>
</tr>
</tbody>
</table>

Source: IMF staff estimates.
Figure 4.10. Analysis of Household Expenditure on Key Food Categories

1. Fitted Engel curve: egg, fish, and meat

2. Fitted Engel curve: milk products

3. Fitted Engel curve: cereals

4. Fitted Engel curve: pulses

5. Fitted Engel curve: vegetables and fruits

6. Fitted Engel curve: other products

Source: IMF staff estimates.

TABLE 4.7

Compensated (Hicksian) Price Elasticities: Second Budgeting Stage (Sample mean values, based on actual expenditure weights)

<table>
<thead>
<tr>
<th>Food Category</th>
<th>Egg, Fish, and Meat</th>
<th>Milk and Milk Products</th>
<th>Cereals and Cereal Products</th>
<th>Pulses and Pulse Products</th>
<th>Vegetables and Fruits</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg, fish, and meat</td>
<td>-0.395</td>
<td>0.142</td>
<td>0.124</td>
<td>0.034</td>
<td>-0.001</td>
<td>0.088</td>
</tr>
<tr>
<td>Milk and milk products</td>
<td>0.125</td>
<td>-0.659</td>
<td>0.119</td>
<td>0.004</td>
<td>0.129</td>
<td>0.131</td>
</tr>
<tr>
<td>Cereals and cereal products</td>
<td>0.255</td>
<td>0.248</td>
<td>-0.623</td>
<td>0.243</td>
<td>0.218</td>
<td>0.263</td>
</tr>
<tr>
<td>Pulses and pulse products</td>
<td>0.012</td>
<td>-0.011</td>
<td>0.072</td>
<td>-0.647</td>
<td>0.059</td>
<td>0.105</td>
</tr>
<tr>
<td>Vegetables and fruits</td>
<td>-0.086</td>
<td>0.141</td>
<td>0.133</td>
<td>0.117</td>
<td>-0.585</td>
<td>0.169</td>
</tr>
<tr>
<td>Other</td>
<td>0.090</td>
<td>0.139</td>
<td>0.175</td>
<td>0.249</td>
<td>0.181</td>
<td>-0.756</td>
</tr>
</tbody>
</table>

Source: IMF staff estimates.
Food Subsidies and Some Distributional Aspects

The 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 the buffer stocks. Note that in recent years, the share of public procurement has risen substantially (Figure 4.11), from an average of 25 percent during 2002/03–2007/08 to 32 percent during 2008/09–2013/14. This has prompted criticism of increasing the state’s role in the cereals market (CACP 2013). The share of public distribution system (PDS) purchases in consumption has also increased considerably (Figure 4.12). In the case of rural household consumption, the share of rice

---

**Figure 4.11. Procurement Trend of Rice and Wheat**
*(Percent of annual production)*

![Graph showing procurement trend of rice and wheat](image)

Sources: CEIC; and IMF staff calculations.

**Figure 4.12. Share of PDS Cereals Purchases in Food Consumption**
*(Percent of household consumption, quantity-based)*

![Graph showing share of PDS cereal purchases in food consumption](image)

Source: National Sample Survey Office.

Note: PDS = public distribution system.
purchases from the PDS rose from 13 percent in 2004/05 to 28 percent in 2011/12, and the share of wheat rose from 7 percent to 17 percent. For urban households, in the same period, the increase was from 11 percent to 20 percent for rice, and from 4 percent to 11 percent for wheat.

With a sizable share of subsidized cereals in the consumption basket of many households, the average price of cereals (PDS and open market) paid by households is below open market prices, and the minimum support price that a cereal producer can receive through the open-ended public procurement system. As a result of subsidized pricing to consumers (Figure 4.13), the weight on cereals from the PDS in expenditures is significantly less than it would be on the basis of quantity. For example, PDS rice in the CPI Combined, which tracks budget shares, is about 8 percent of the total expenditure on rice, while the quantity of PDS rice is about 25 percent of the total quantity. For wheat, the discrepancy is also nontrivial: 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 PDS rice was about a quarter of the open market price, while the price of wheat from PDS was about a third of its open market price (see also Basu and Das 2014).

The share of rice consumed from the PDS is significantly higher for poorer households, which benefit from the TPDS, in particular the Below Poverty Line and Antyodaya Anna Yojana schemes; and because poorer households essentially face a different set of prices of cereals than the richer households. Our demand specification does not account for possible links between the rupee amount of household budgets and the available prices of cereals. As such, we attribute relatively higher cereal consumption by poorer households to the lower price rather

---

**Figure 4.13. Government Food Subsidies**

*Percent of GDP*

![Graph showing government food subsidies as a percentage of GDP from 2000/01 to 2012/13.](Source: IMF staff calculations.)
than to their smaller budgets. 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 the in-kind nature of the TPDS. Moreover, it does not account for leakages, which are estimated to be large (CACP 2013). 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.

BUFFER STOCKS AND MINIMUM SUPPORT PRICES

Buffer Stocks

In this section, we quantify the impact of the buildup of buffer stocks on India’s relative food inflation over the past decade. Specifically, we estimate relative food inflation because of the diminished net supply of cereals into the market from the buildup of buffer stocks. We also estimate the impact of a hypothetical (and counterfactual) proactive buffer stock liquidation policy on relative food inflation volatility.

It has been frequently argued that the excessive buildup of buffer stocks for cereals (rice and wheat) contributed to India’s inflationary pressures in the past several years (CACP 2013). The cumulative buildup of the buffer stock of rice over a six-year period from 2007/08 to 2012/13 was close to 20 million tons, while average production was about 100 million tons. The buildup of wheat stocks was even more significant; 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 85 million tons per year. The rice intake into the Central Pool averaged 4 percent of annual output during this period, and nearly 7 percent for wheat. As a result, by July 2012, India’s stocks of rice and wheat accounted for more than 6 percent and 7 percent of the world’s total rice and wheat utilization, respectively (Saini and Kozicka 2014). Since 2010, on average, actual buffer stocks held with the Food Corporation of India were more than double the norms. Several underlying reasons account for this situation, including distortions such as export bans and open-ended procurement. But a key reason appears to be lack of a proactive liquidation policy. The inefficiency of the buffer stock policy has been aggravated by the significant costs of carrying excess stocks, considering that the economic cost to the Food Corporation of India for acquiring, storing, and distributing food grains has been some 40–50 percent more than the procurement prices (Gulati, Gujral, and Nandakumar 2012).

In practice, minimum support price increases are announced in advance of the agricultural season, the actual intake to buffer stock following harvesting has a

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For example, the bottom decile of 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.
further impact on inflation dynamics, because it reduces the quantity of cereals available for households’ purchases on the open market, especially during a poor output period. Even though minimum support prices essentially provide a floor for open market prices, in part due to an open-ended procurement policy, the actual postharvest buffer stock intake and household demand define the eventual open market prices. Figure 4.14 illustrates a simplified interaction of postharvest short-term supply and demand for cereals. If we abstract away from international trade aspects, we can assume that the postharvest short-term cereal supply curve is vertical. In addition, we assume that the government’s decision on the buildup of buffer stocks 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.

Indeed, the actual monthly price dynamics suggest that WPI cereal inflation during the months of peak buffer stock intake significantly exceeded minimum support price increases (Figure 4.15). For example, by mid-2013 wholesale price inflation for rice exceeded 20 percent compared to the minimum support price growth of about 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 minimum support price policies and output. In other words, the intake and liquidation of stocks can smooth consumption and stabilize prices.

Specifically, we model relative food inflation dynamics under an alternative (counterfactual) scenario with two key properties related to buffer stock policies. First, we take into account the revised buffer stock norms and calculate the inflationary effect of releasing the excess stock relative to the new norm on relative food inflation. In particular, we adopt the government’s recently approved buffer norms,
reflecting the needs of the National Food Security Act. 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 norm levels. More specifically, we assume a lower cumulative buffer stock intake between July 2007 and July 2012, by about 15 million metric tons for rice and by about 20 million metric tons for wheat. Our estimates suggest that this would have resulted in a reduction in food inflation by about ½ percentage point 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 proactive cereal liquidation policy, which involves 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. We estimate the impact of such policy on reducing relative food inflation volatility. Conditional on the implementation of revised buffer stock norms by mid-2013, smoothing the growth rate of cereal consumption at slightly below 1½ percent per year through a proactive intake and release of buffer stocks could have reduced the standard deviation of historic relative food inflation during this period by half—from about 3¼ percentage points to just about 1½ percentage points (Figure 4.16). Note that by focusing only on

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9The 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 tons of wheat and about 13.5 million metric tons of rice to be maintained on July 1. As of July 1, 2012, which was a near-peak stock holding period, Food Corporation of India stocks amounted to 49.8 million metric tons of wheat and 30.7 million metric tons of rice.
modeling the relative food inflation and keeping the path of nonfood inflation unchanged, we ignore potential second-round effects of elevated food inflation on core inflation, which are nontrivial (Anand, Ding, and Tulin 2014). Therefore, our exercise likely understates the additional impact on aggregate retail inflation, particularly at times of elevated food inflation.

Minimum Support Prices

The strong buildup of buffer stocks was undoubtedly aided by strong rises in minimum support prices, which 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 minimum price increases were generally followed by rising inflation in key agricultural crops (Rajan 2014). This suggests that minimum support price increases have played a role in fueling inflationary pressures, including by chipping away the production of other crops. Nonetheless, incentive schemes, such as minimum support prices, were also found to have contributed to increased cereal production during this period.\(^\text{10}\) Growth of cereal production averaged about 1¼ percent per year during 1995/96–2005/06 when the growth of minimum support prices 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 minimum support prices exceeded headline WPI inflation by about 4½ and headline CPI inflation by about 2 percentage points.

Kozicka and others (2014) argue that minimum support prices likely helped increase cereal production, which helped underpin the rebuilding of buffer stocks of cereals and increase household consumption. Nevertheless, as a policy instrument the role of minimum support prices was much broader, because by design they ensure a remunerative and stable price environment. Thus, even though the buildup of buffer stocks over the past decade was very strong, enabled in part by procurement policies including minimum support prices, it nevertheless appears to have been less than the estimated cereal production gains. And this was caused partly by the strong growth in minimum support prices. 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 point 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.

\(^{10}\) Using estimates of cereal’s supply elasticity of about 0.3 for minimum support prices (WPI deflated) reported by Kozicka and others (2014), the impact of these prices on production may have been significant. Specifically, minimum support prices 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.
Understanding India’s Food Inflation Through the Lens of Demand and Supply

Under the assumptions of (1) a price-floor policy of the minimum support price, (2) minimum support prices resulting in increased production relative to the market equilibrium without government subsidies, and (3) the absence of buffer stock buildup, ensuring postharvest market clearing of an increased supply of cereals necessitates a subsidy to the consumer (Figure 4.17). Indeed, the average consumer prices of cereals purchased at subsidized prices from the PDS and the open market tended to be below minimum support prices, even though the open market wholesale prices of cereals generally exceed these prices (Figure 4.18). For example, cereal expenditure shares and consumption volumes suggest that PDS prices are about a quarter of the retail prices for rice, and a third of the retail prices for wheat.

Thus, from the perspective of consumer demand, if higher minimum support prices lead to higher supply and therefore higher consumption of cereals, higher minimum support prices might also result in lower inflation (quantity weighted) for cereals relative to nonfood inflation. However, the increased availability of cereals may also lead to further demand pressures on other food commodities, including as a result of their reduced supply due to production distortions generated by the minimum support price. Also, given the government’s policy to enhance the supply of cereals and make them available to households at subsidized prices, this means increasing the fiscal costs of minimum support price

![Figure 4.17. Minimum Support Price and Supply, and Household Demand for Cereals](image)

Note: MSP = minimum support price; PDS = public distribution system.
policies. However, it is precisely the minimum support price mechanism, in combination with open-ended procurement, that can generate overall inflationary pressures. Given a relatively large share of cereals in household consumption, an essentially administered setting of their prices as a result of the minimum support price policy, open-ended procurement, and food subsidy policies can lead to generalized inflationary pressures. In other words, even though relative food inflation may end up lower, nonfood and also headline inflation can rise significantly as they become anchored by inflation caused by minimum support prices.
Note that our simulation framework is aimed at explaining relative food inflation for a given level of nonfood inflation rather than establishing a causal relationship. A possible simulation approach, of course, could be to tie food and nonfood prices to administered prices, such as the minimum support price, and then solve for inflation dynamics conditional on cereal price inflation. It is not clear to what extent this is a useful exercise because, while not trivial, products subject to minimum support prices constitute a relatively small share of total consumption. In this case, time-series techniques aimed at identifying causal links may be better suited, as examined in Sonna and others (2014), for example. Controlling for real incomes, demand for protein, and agricultural input costs, they find that a 1 percentage point increase in the production-weighted minimum support price of rice and wheat is associated with about a 0.3 percentage point increase in food inflation. In addition, on the basis of weak exogeneity tests, they conclude that in the short-term, minimum support prices have a statistically significant impact on food inflation. Similarly, Anand, Ding, 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.

Finally, empirical evidence provided by Anand, Kumar, and Tulin (2016) suggests that, except in the short term, minimum support prices of cereals tend to react to changes in Indian farm gate prices of cereals, rather than the other way around. They also find that international market prices influence Indian farm gate prices and minimum support prices, in both the short and long term. The global market price will thus remain important in defining Indian cereal prices in the long term.

**IMPLICATIONS FOR MONETARY POLICY**

Our modeling framework does not take into account that 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. And it may be particularly limiting when analyzing long-term food inflation dynamics.

As discussed, the approach of abstracting away from explicit modeling of food supply is not without limitations, 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 Agricultural Policy Research Institute’s Elasticity Database, for example, indicates that the price elasticities of rice supply are usually close to 0.2, with a 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, 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 for minimum support prices, estimated by Kozicka

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11 As in an inelastic supply system, only price, not supply, adjusts to equilibrate demand.
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 minimum support prices. 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 estimate relative food inflation dynamics under different scenarios for supply growth (Table 4.8). Under the historic scenario for this, average growth rates of domestic food supply in the recent decade, food inflation would exceed nonfood inflation by about 3 percentage points per year, thus contributing about 1½ percentage points to the headline inflation in excess of underlying nonfood inflation. Under a preferred growth scenario, which assumes that the rates of supply growth of all food categories are raised by about 1 percentage point per year, food inflation would exceed nonfood inflation by only about ½ of a percentage point. We also consider a conservative growth scenario that assumes a growth rate for cereal production at about ¾ percent per year, implying stagnant cereal productivity and/or the absence of policy support. In this scenario, food inflation would exceed nonfood inflation by 4 percentage points per year.

Moreover, taking into account historic food supply growth volatility and absent a proactive buffer stock policy, relative food inflation could contribute close to 1½ percentage points to headline inflation over a two-year period. In turn, a proactive 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 will need policies to enhance food supply. For example, in the absence of increased food supply growth, average long-term nonfood inflation would need to be brought down to about 2½ percent, 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 is worth noting that if long-term

12 Increase in relative food inflation over two years in response to one standard deviation shock to domestic food supply.
average inflation were higher, the upper band would probably be breached more often or would need a more aggressive monetary stance. Our analysis also suggests that administered price setting, such as through minimum support prices 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 proactive 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 food inflation shocks to core inflation.

CONCLUSIONS AND POLICY IMPLICATIONS

During the decade just past, 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 term. The acceleration of India’s economic growth during the past 10 years, accompanied by stagnant agriculture growth, resulted in excess demand for food, giving rise to relative food price inflation. Furthermore, the excessive buildup in buffer stocks since 2007/08 and the lack of a proactive 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 toward more nutritious and high-value foods. Recent steps to contain food inflation will help in the short term, until 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 adjusting the buffer norms of food grains to levels significantly below prevailing actual stocks have helped lower cereal (rice and wheat) inflation. However, India’s agricultural yields for key food commodities remain significantly below those of many emerging markets; rice yields, for example, are about one-third of China’s and about half of Vietnam’s and Indonesia’s (Himani 2014). The excess demand will likely reemerge; and thus a durable increase in supply, particularly through enhancing agricultural yields for key commodities, will be required to keep food inflation in check. For cereals, the impact of price support and stabilization policies will need to be complemented by policies to enhance agricultural productivity, including along the lines of the FCI Restructuring Committee Report (Government of India 2015).

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 nonfood inflation by 2½–3 percentage points per year, assuming private consumption growth picking up to 7 percent
per year and food supply growing at historic rates. Therefore, the sustainability of a long-term inflation target of 4 percent under the recently adopted flexible inflation targeting 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. Our simulation analysis also 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 help mitigate food inflation volatility. Finally, administered price setting, such as through minimum support prices and supporting policies, will continue to pose challenges for monetary policy management in India, as highlighted in the Patel Committee Report.
### ANNEX 4.1. ESTIMATED PARAMETERS OF THE QUADRATIC ALMOST IDEAL DEMAND SYSTEM FOR INDIA

**ANNEX TABLE 4.1.1**

**Regression Analysis of Total Food Demand: First Budgeting Stage**

<table>
<thead>
<tr>
<th>Dependent Variable: Food Expenditure Weight</th>
<th>All Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_1$</td>
<td>0.9147661 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0139673)</td>
</tr>
<tr>
<td>$\gamma_1$</td>
<td>0.0040952 **</td>
</tr>
<tr>
<td></td>
<td>(0.0019713)</td>
</tr>
<tr>
<td>$\beta_1$</td>
<td>−0.1710632 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0030094)</td>
</tr>
<tr>
<td>$\lambda_1$</td>
<td>0.0035315 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0002866)</td>
</tr>
<tr>
<td>$a_0$</td>
<td>−0.3615261 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0871973)</td>
</tr>
</tbody>
</table>

$R^2$, difference of freedom adjusted: 0.96
Number of observations: 138,055

Source: IMF staff estimates.

*** denotes significance at the 1 percent level; ** at the 5 percent level.
ANNEX TABLE 4.1.2
Regression Analysis of Food Demand: Second Budgeting Stage

|   | \( \alpha_1 \) | \( \beta_1 \) | \( \alpha_2 \) | \( \beta_2 \) | \( \alpha_3 \) | \( \beta_3 \) | \( \alpha_4 \) | \( \beta_4 \) | \( \alpha_5 \) | \( \beta_5 \) | \( \gamma_{1,1} \) | \( \gamma_{2,2} \) | \( \gamma_{3,3} \) | \( \gamma_{4,4} \) | \( \gamma_{5,5} \) | \( \gamma_{6,6} \) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0088237 | -0.0906848 *** | 0.7792011 *** | -0.0906848 *** | 0.0045011 | -0.1362998 *** | 0.0335076 *** | 0.004809 | 0.0460594 *** | -0.0685883 *** | 0.0508396 *** | 0.1561513 *** | 0.00311 *** | 0.0032823 *** | 0.003492 |
| 2 | (0.0105971) | (0.0056052) | (0.0037655) | (0.005724) | (0.00788) | (0.0037655) | (0.004138) | (0.023344) | (0.0084569) | (0.005724) | (0.0014078) | (0.0033231) | (0.007133) | (0.003766) | (0.0006421) |
| 3 | -0.0362661 *** | -0.0012684 ** | 0.0130379 *** | 0.0173077 *** | 0.0070304 *** | 0.003379 | -0.0119021 *** | -0.0032853 *** | -0.0331631 *** | 0.0003527 | -0.0105381 *** | -0.00362661 *** | -0.0085266 *** | -0.0012684 ** | (0.0022921) |
| 4 | (0.0014078) | (0.005724) | (0.0025156) | (0.003766) | (0.00025156) | (0.0003492) | (0.0003492) | (0.0003492) | (0.002574) | (0.003766) | (0.002557) | (0.0012753) | (0.0033231) | (0.0012753) | (0.0006421) |
| 5 | 0.0508396 *** | 0.0059947 *** | 0.0070304 *** | 0.003379 | 0.0130379 *** | 0.0173077 *** | -0.0119021 *** | -0.0032853 *** | 0.0070304 *** | 0.0059947 *** | 0.005015 | 0.007133 | 0.007133 | -0.0032853 *** | (0.0022921) |
| 6 | (0.0014078) | (0.005724) | (0.00025156) | (0.0003492) | (0.0003492) | (0.0003492) | (0.0003492) | (0.0003492) | (0.00025156) | (0.0003492) | (0.00025156) | (0.0003492) | (0.0003492) | (0.0003492) | (0.0003492) |

Backed-out remaining QUAIDS coefficients:

\[ \alpha_6 = 0.1279071 *** \]
\[ \beta_6 = -0.0034218 \]
\[ \gamma_{1,6} = -0.0086787 *** \]
\[ \gamma_{2,6} = -0.0085266 *** \]
\[ \gamma_{3,6} = 0.0003557 \]
\[ \gamma_{4,6} = 0.0048146 *** \]
\[ \gamma_{5,6} = 0.0004301 \]
\[ \gamma_{6,6} = 0.0032823 *** \]

Additional coefficient restrictions:

\[ \gamma_{2,1} = \gamma_{1,2} \]
\[ \gamma_{3,1} = \gamma_{1,3} \]
\[ \gamma_{5,1} = \gamma_{1,5} \]
\[ \gamma_{6,1} = \gamma_{1,6} \]
\[ \gamma_{2,2} = \gamma_{2,2} \]
\[ \gamma_{3,2} = \gamma_{2,2} \]
\[ \gamma_{4,2} = \gamma_{2,2} \]
\[ \gamma_{5,2} = \gamma_{2,2} \]
\[ \gamma_{6,2} = \gamma_{2,2} \]
\[ \gamma_{2,3} = \gamma_{2,3} \]
\[ \gamma_{3,3} = \gamma_{2,3} \]
\[ \gamma_{4,3} = \gamma_{2,3} \]
\[ \gamma_{5,3} = \gamma_{2,3} \]
\[ \gamma_{6,3} = \gamma_{2,3} \]
\[ \gamma_{2,4} = \gamma_{2,4} \]
\[ \gamma_{3,4} = \gamma_{2,4} \]
\[ \gamma_{4,4} = \gamma_{2,4} \]
\[ \gamma_{5,4} = \gamma_{2,4} \]
\[ \gamma_{6,4} = \gamma_{2,4} \]
\[ \gamma_{2,5} = \gamma_{2,5} \]
\[ \gamma_{3,5} = \gamma_{2,5} \]
\[ \gamma_{4,5} = \gamma_{2,5} \]
\[ \gamma_{5,5} = \gamma_{2,5} \]
\[ \gamma_{6,5} = \gamma_{2,5} \]
\[ \gamma_{2,6} = \gamma_{2,6} \]
\[ \gamma_{3,6} = \gamma_{2,6} \]
\[ \gamma_{4,6} = \gamma_{2,6} \]
\[ \gamma_{5,6} = \gamma_{2,6} \]
\[ \gamma_{6,6} = \gamma_{2,6} \]

\[ R^2: \omega_1 = 0.77 \]
\[ R^2: \omega_2 = 0.77 \]
\[ R^2: \omega_3 = 0.90 \]
\[ R^2: \omega_4 = 0.87 \]
\[ R^2: \omega_5 = 0.91 \]

Number of observations: 302,783,433.00

Source: IMF staff estimates.

Note: Robustness standard errors in parentheses. QUAIDS = quadratic almost ideal demand system.

*** denotes significance at the 1 percent level; ** at the 5 percent level.

1 Subscripts denote the following food categories: 1 = milk and milk products; 2 = egg, fish, and meat; 3 = cereals and cereal products; 4 = pulses and pulse products; 5 = vegetables and fruits; 6 = other (oils and fats, sugar, condiments, and spices).
REVIEW REFERENCES


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