INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
IFPRI

INTEGRATED FOOD POLICY RESEARCH PROGRAM | WORKING PAPER 013 JULY 2024

Foresight for Food Markets

Developing and implementing market forecasting methods/models

Paul Dorosh, Shoumi Mustafa, Razin Iqbal Kabir, and Nabila Afrin Shaima

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
IFPRI

CONTENTS

TABLES

FIGURES

LIST OF ACRONYMS

BDT/Tk.	Bangladeshi Taka
BIDS	Bangladesh Institute of Development Studies
BPL	Below Poverty Line
CPI	Consumer Price Index
DAM	Department of Agricultural Marketing
DAE	Department of Agricultural Extension
DG Food	Directorate General of Food
DG FPMU/FPMU	Directorate General of the Food Planning and Monitoring Unit
DSGD	Development Strategy and Governance Division
FOB	Free on board
GDP	Gross Domestic Product
GoB	Government of the People's Republic of Bangladesh
HIES	Household Income and Expenditure Survey
IFPRI	International Food Policy Research Institute
IFPRP	Integrated Food Policy Research Program
JV	Joint Venture
kg	Kilogram
MFSP	Modern Food Storage Facilities Project
MoFood	Ministry of Food
MT	Metric tons
NBR	National Board of Revenue
PFDS	Public Foodgrain Distribution System
PMU	Project Management Unit
SAR	South Asia Region
SD	Standard deviation
UIUC	University of Illinois at Urbana-Champaign
USD	United States Dollars
USDA	United States Department of Agriculture

PREFACE

The “Foresight for Food Markets: Developing and Implementing Market Forecasting Methods/Models with Hands-on Training at the FPMU” is an element of Integrated Food Policy Research Program (IFPRP). Originally signed in 2016 between the Government of Bangladesh (GoB) and the Joint Venture (JV) comprising the International Food Policy Research Institute (IFPRI), the Bangladesh Institute of the Development Studies (BIDS), and the University of Illinois, IFPRP was extended and modified in subsequent periods. The most recent updated contract between the GoB and the JV was signed in mid-2022. Deliverable 4.3, Foresight for Food Markets: Developing and Implementing Market Forecasting Methods/Models with Hands-on Training at the FPMU is one of the new deliverables included in the updated contract.

Rising prices of essential commodities affect consumer welfare and pose a serious challenge to the Government of Bangladesh. Knowing prices of essentials in advance would allow the government to take necessary measures to restrain the extent of price increases or to mitigate effects of rising prices; such measures could include provisions of direct distributions of rice and wheat through social safety net programs or of subsidized open market sales on the one hand and engaging in direct imports of essentials or easing import restrictions for the private sector, on the other.

Because price fluctuations are a feature of a free market, there is a persistent need for the government to be able to project consumer prices in advance. Accordingly, it is important that in addition to receiving estimates prepared by external experts, the government has the ability to obtain its own price projections; the government should have the estimates when it needs them and for commodities for which such information is needed.

Against this backdrop, IFPRP is providing hands-on training on price projection techniques to officials from the Food Planning and Monitoring Unit (FPMU), the Directorate General of Food (DG Food), and the Ministry of Food (MoFood). It is envisioned that trained officials from the DG Food, the Ministry of Food, and mostly from the FPMU will produce price projection estimates on their own with IFPRP personnel helping a consultative capacity.

1 INTRODUCTION

While rising household income in Bangladesh has generally boosted the demands for essential food items, supplies of the same items are often susceptible to weather shocks, fluctuating world prices, and abrupt policy changes in major producing countries. Restrictions on the export of onions and lentils from India, for example, have influenced Bangladesh prices in the past. Unexpected price movements of essential food items affect consumer welfare and can pose societal concerns. As such, advanced knowledge of future prices of essentials would be a major strength for the government of Bangladesh. Although the markets for food items are mostly free, the government can influence prices by improving supply conditions through the easing of imports or by increasing direct distributions (for rice and wheat only).

Because price fluctuations are a feature of the free market, there is a persistent need for the government to be able to project consumer prices in advance. Accordingly, it is important that in addition to receiving estimates prepared by external experts, the government develops the capacity to prepare its own price projection estimates of essential commodities. To this end, the Integrated Food Policy Research Program (IFPRP) organized a two-day training session with staff from the Food Planning and Monitoring Unit (FPMU), Ministry of Food (MoFood) and Directorate General of Food (DG Food) from July 20 to July 21, 2022, at the premises of the FPMU.

The mission of this training program was to inculcate a better understanding of broad conceptual and theoretical issues related to food policies in the domestic and international milieu. The training provided the participants with conceptual data, which promoted critical thinking and free discussion on the theoretical concepts and application of the price projection model. It is expected that the technical skills imparted to the participants will enable them to engage in discussions on policy rationales and consequences in an informed way.

The price analyses and projections discussed in this course of training can serve as policy tools to guide decision-making in the near term. The projections provide important information on the present state of the market and an indication of expected price movements. It is important to understand the limitations of these methods, in that the projections (by definition) cannot predict shocks, instead reflecting long-term trends and inflation. We use confidence intervals to highlight the inherent uncertainty in any such exercise.

This report is organized as follows. Chapter 2 outlines the training program, summarizes the lectures, and highlights the proceedings of the two days of training. Chapter 3 details the training modules and methods involved in generating price projections of food commodities. Next, Chapter 4 introduces a simulation analysis of supply, demand and prices, highlighting the short-run impact of a production shock. Finally, Chapter 5 presents agricultural price analysis and projections from August 2022 up to January 2023 for several key commodities using the methods introduced during the training.

2 OVERVIEW OF THE TRAINING PROGRAM

As part of its capacity building agenda, the IFPRP provided hands-on training on price projection techniques to officials from the Food Planning and Monitoring Unit (FPMU), the Directorate General of Food (DG Food), and the Ministry of Food (MoFood). It is envisioned that trained officials from the DG Food, the Ministry of Food, and mostly from the FPMU will produce price projection estimates on their own with IFPRP personnel helping a consultative capacity.

Given the importance of knowing prices of essentials in advance, this training event covered the methods required to produce price projections for essential food items, focusing mainly on rice and wheat. The event, titled "Training on Market Price Analysis and Projections", aimed to provide hands-on training on the basics of descriptive statistics and trend analysis, relevant topics such as inflation, the theoretical concepts and application of the price projection model, and discussions on alternative approaches such as supply and demand simulations. The training agenda can be found in Annex 1.

2.1 Basic details

The two-day long training was participated by 12 select government officials of the Ministry of Food, the Food Planning and Monitoring Unit, and the Directorate General of Food. The training was held at the FPMU Conference Room, Khaddyo Bhaban, Dhaka.

Training title : **"Training on Market Price Analysis and Projections"**
Number of trainees : 12 (Male: 11; Female: 1)
Duration of the training : 2 days (July 20 – July 21, 2022)

2.2 Selection of trainees

In coordination with the FPMU and with DG Food senior management, a list of tentative trainees was developed. The list was then screened by the senior management to ensure that participants willing to continue their services with the Department of Food were included in the list. The list was also screened by the Ministry of Food to ensure that relevant officials of the ministry were also included in the list. Trainees included staff from FPMU office, DG Food offices and from Ministry of Food. A list of the trainees is provided in Annex 2.

2.3 Profiles of the trainers

DR. PAUL A. DOROSH

Director
Development Strategy and Governance

International Food Policy Research Institute

Paul A. Dorosh has been the Division Director of IFPRI's Development Strategy and Governance Division since April, 2011. His previous positions include IFPRI Senior Research Fellow and Program Leader of the Ethiopia Strategy Support Program in Addis Ababa (2008-2010), Senior Economist at the World Bank (2003-2008), senior research fellow with IFPRI in Dhaka, Bangladesh (1997-

2001) and Associate Professor at Cornell University (1994-97). He holds a Ph.D. in Applied Economics from the Food Research Institute, Stanford University and a B.A. in Applied Mathematics from Harvard University, and has published research on agricultural markets, food policy, international trade, economy-wide modeling and the rural-urban transformation.

DR. SHOUMI MUSTAFA

Senior Research Coordinator
South Asia Region

International Food Policy Research Institute

Shoumi Mustafa served as a Senior Research Coordinator in the South Asia Regional Office (SAR). He joined IFPRI in 2019. He worked on grain storage and transportation logistics, market and policy analysis, and on capacity enhancements. Dr. Mustafa was posted in Bangladesh where he lead the Dhaka office of the Integrated Food Policy Research Program, a World Bank-financed project undertaken with the Government of Bangladesh. Prior to joining IFPRI, Dr. Mustafa worked for the state government of Ohio at the Department of Higher Education. Dr. Mustafa has a Ph.D. in Economics from Ohio State University and an M.Phil. in Economics from the University of Cambridge.

RAZIN IQBAL KABIR

Senior Program Manager
South Asia Region

International Food Policy Research Institute

Razin Iqbal Kabir is a Senior Program Manager in the South Asia Regional Office. He joined IFPRI in December 2016 as part of the Integrated Food Policy Research Program (IFPRP). He is a quantitative researcher interested in food security, nutrition and agriculture policy. His work for the IFPRP has included establishing loss estimates for public food-grain storage, as well as undertaking the largest survey of the rice value chain in Bangladesh to provide national estimates of private sector stocks. Recently, his work has focused on assessing the impacts of the ongoing Covid-19 pandemic on the performance of rice, fish and shrimp value chains in Bangladesh. Prior to joining IFPRI, Mr. Kabir was a public health researcher for the James P. Grant School of Public Health at BRAC University. He received both his master's in international public health and bachelor's in medical science (Immunobiology) from The University of Sydney, Australia.

2.4 Training sessions

The 2-day long training workshop was broken down into two sessions incorporating 5 lectures comprising of descriptive statistics and methods for analyzing long-term trends, especially sequenced for the convenient learning of the select trainees.

2.5 Inauguration session

Held at the Conference Room of the Food Planning and Monitoring Unit (FPMU) premises, the workshop was inaugurated by the FPMU Director General, Mr. Md. Shahiduzzaman Faruki. Dr. Paul Dorosh, Director, Development Strategy Governance Division (DSGD), IFPRI presented his remarks and kickstarted the training program. The inauguration session was attended by the trainees along with government officials from the FPMU.

2.6 Training components

2.6.1 Presentation 1: Introduction to the course (Day 1)

The first session of day one of the training program began with an introduction to market prices as indicators of current and expected supply and demand. Dr. Paul Dorosh provided a concise lecture on the applications of forecasting short-term future prices to Bangladeshi agricultural product markets. He emphasized on how in a market economy, domestic prices change in response to changes in supply, consumer preferences, policy, world prices, and other factors. He presented examples and simulations depicting the short-run impact of a supply shock. He further stated that the short-term price forecasting approach developed by IFPRI is able to closely replicate price movements in early 2019 (January-May/June) for rice, wheat and several other major commodities. Dr. Dorosh expanded upon the analysis of rice and wheat prices, including incentives for private sector imports which have played a crucial role in price stabilization in Bangladesh in the past.

2.6.2 Presentation 2: Descriptive statistics and trends (Day 1)

Continuing from the first session of day one of the training program, the participants were given a refresher course on measures of central tendency, measures of dispersion, moving averages and seasonality by Razin Kabir. He clarified various statistical theories with examples and incorporated hands-on excel exercises as part of the training course.

2.6.3 Presentation 3: Inflation, CPI and real prices (Day 1)

In this training session, Razin Kabir detailed the basics of price changes in agriculture and the essentials of real price adjustments. The second session of day one of the training program continued with an introduction to the elements involved in understanding real prices. The topics brought forward in this session include the basics of inflation and real prices; the application of the consumer price index (CPI) in calculating real prices; and application of the seasonality index. The session also contained hands-on Excel practice exercises for better understanding of the trainees.

2.6.4 Presentation 4: Manual for price analysis and projections for key food commodities (Days 1 and 2)

This section was covered during two days of the training. On the first day of the training program, Dr. Shoumi Mustafa and Razin Kabir reviewed key food commodities in Bangladesh based on current prices, past price patterns in domestic and international markets, existing macro food inflation rate, and information on likely demand shocks. They explained the equation for the price projection model and broke down each component of the equation to better describe the relevance of each factor in determining projected prices. Razin Kabir provided hands-on excel exercises to show the participants how to generate actual and projected prices for coarse and medium rice. This course

was again recapped on the second day—this time the projection model was simulated to determine projected prices for wheat.

2.6.5 Presentation 5: Simulation analysis of supply, demand and prices (Day 2)

On the second day of the training program, the participants reviewed concepts and worked on excel exercises to better understand topics such as supply, demand, international trade, import parity, prices and import. Dr. Dorosh reviewed previous research on price instability and associated policy options to manage it. He also explained the relationship among rice prices in Bangladesh. Razin Kabir assisted the participants to simulate the impact of alternative policies on rice price stability in Bangladesh.

2.7 Closing session

The closing session of the 2-day training workshop was participated by Mr. Md. Ismiel Hossain ndc, Secretary, Ministry of Food; Mr. Md. Shahiduzzaman Faruki, Director General, FPMU; Mr. Abdullah Al Mamun, Additional Director General, DG Food; Dr. Paul A. Dorosh, Director of DSGD, IFPRI; and Dr. Shoumi Mustafa, Senior Research Coordinator of IFPRI. Selected senior and mid-level government officials from FPMU, DG Food and the MoFood also attended the certificate awarding ceremony.

Mr. Md. Ismiel Hossain ndc, Secretary, Ministry of Food stated that training is an important component for food policymakers and food policy implementers, as it enables the trainees to analyze and understand crisis situations in a better way. He mentioned that the training hopefully promises to be one milestone on the way of transition towards a more healthy and equitable future. He highlighted the efforts of the IFPRI team and also remarked upon the need for such training programs which would prove beneficial for the country.

Mr. Md. Shahiduzzaman Faruki, Director General, FPMU, remarked upon the efforts and assistance that the IFPRI team has been extending to the project program and the training sessions. He remarked upon the importance of Food Security and the subsequent gain of skills developed by the trainees throughout the course of the training. He stated that IFPRI has been playing an encouraging role over decades in training food officials, and that the trainings are helping food officials make efficient food policy decisions.

Mr. Abdullah Al Mamun, Additional Director General, DG Food, appreciated the efforts of the IFPRI-led consortium to ensure an effective learning process for the select trainees. He also stated that the training is an important component for food policymakers and food policy implementers, as it enables the trainees to analyze and understand crisis situations in a better way. He further shared that the training will be a success only if the trainees apply the training knowledge in their workplace.

Dr. Paul A. Dorosh, Director, DSGD, IFPRI, remarked upon the work of IFPRI researchers and their collective roles in providing quality research and policy recommendations for the country. He also stated that that further training could serve to help officials to stay up to date with new policies and policy analysis tools.

Finally, Dr. Shoumi Mustafa presented his vote of thanks and expressed his pleasure for being a part of the closing ceremony. He congratulated the participants for the successful completion of the training program and stated that the training concepts and practical work can be a part of the FPMU's regular work.

The closing ceremony ended with the handing over of the certificates to respective trainees. The pictures from the training program are available in the Annex 6.

3 TRAINING MODULES ON GENERATING PRICE PROJECTIONS OF KEY FOOD COMMODITIES

3.1 Module 1: Descriptive statistics and trends

The training program covered the following topics with regard to generating descriptive statistics and analyzing trends:

- Measures of central tendency: Mean, median, and mode;
- Measures of dispersion: Standard deviation and variance;
- Moving averages; and
- Seasonality.

3.1.1 Measures of central tendency

Mean

In statistics, the mean is one of the three main measures of central tendency, alongside the median and the mode. The arithmetic mean or average (simple average) of a set of values is the sum of the values divided by the number of values, such that:

$$\bar{x} = \mu = \frac{1}{n}\left(\sum_{i=1}^{n} x_i\right) = \frac{x_1 + x_2 + \cdots + x_n}{n}$$

where, $\bar{x} = \mu =$ the arithmetic mean;
$n =$ the total number of observations (or size of the sample); and
$i =$ any integer from 1 to n.

For example, if we have five apples whose prices are 5, 6, 7, 8 and 9 taka respectively, then the mean or simple average price would be (5+6+7+8+9)/5=7 taka.

In Excel, the formula for calculating the mean of a range of values is as follows:
=AVERAGE(cell range).

Median

The median of a set of values is the “middle value” when the values are sorted from smallest to largest. This effectively means that 50% of the observations are below this number, and 50% are above it.

In an odd number of ordered observations, the median is calculated as follows:

$$median(x) = x_{(n+1)/2}$$

For example, in a set of 7 numbers ordered 1, 3, 4, 6, 9, 9, 10, the median is the (n+1)/2th term = (7+1)/2 = 4th term, i.e., 6.

In an even number of observations, the median is effectively the average of the two ‘middle’ terms:

$$median(x) = \frac{x_{(n/2)} + x_{(n/2)+1}}{2}$$

For example, in set of 6 numbers ordered 1, 2, 5, 7, 8, 8, the median is the (n/2)th term (3rd term) plus the (n/2)+1th term (4th term) divided by 2, i.e., (5+7)/2 = 6.

In our previous example on the price of apples, the median price would be the 3rd term, i.e., 7 taka.

Like the mean, the median of a range of values can be calculated in Excel as follows:
=MEDIAN(cell range).

Mode

The mode is the value that appears most often in a set of data values. Like the statistical mean and median, the mode is a way of expressing, in a (usually) single number, important information about a random variable or a population. The numerical value of the mode is the same as that of the mean and median in a normal distribution, and it may be very different in highly skewed distributions.

For example, the mode of the sample [1, 3, 6, 6, 6, 6, 7, 7, 12, 12, 17] is 6.

Given the list of data [1, 1, 2, 4, 4], we find that the mode is not unique.

In Excel, we can calculate the mode of a range using the following formulas:
=MODE.SNGL(cell range) ➔ in the case of a range containing single mode; and
=MODE.MULT(cell range) ➔ in the case of a range containing multiple modes.

3.1.2 Measures of dispersion

Standard deviation

The standard deviation (SD) is a measure of the variation in a set of values, and one of the main measures of dispersion in statistics. A low standard deviation indicates that the values tend to be close to the mean, and a high standard deviation indicates that they are spread out over a wider range.

In the simplest terms, the standard deviation (σ) of a sample of values is as follows:

$$\sigma = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2}$$

where, $\{x_1, x_2, \cdots, x_N\}$ are the observed values, and $\bar{x}$ is the mean of these observed values. N is the size of the sample, and $N-1$ is the number of degrees of freedom.

In Excel, the standard deviation can be calculated as follows:
=STDEV.S(cell range).

Variance

The variance (σ^2) is the expectation of the squared deviation of a random variable from its population mean or sample mean.

$$\sigma^2 = \frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2$$

where $\{x_1, x_2, \cdots, x_N\}$ are the observed values, and $\bar{x}$ is the mean of these observed values. N is the size of the sample, and $N-1$ is the number of degrees of freedom.

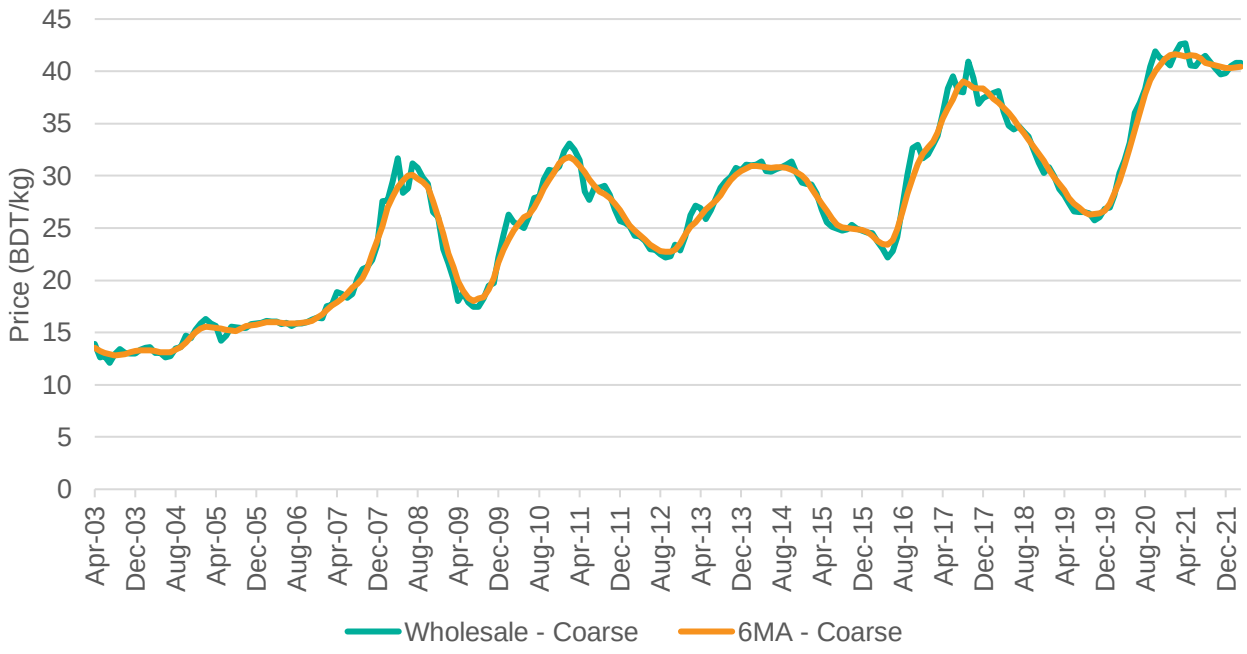
Note that the standard deviation is in effect the square root of the variance.

3.1.3 Moving average

A simple moving average (or rolling/running average) is the unweighted mean of a number of data points in a series. For a given period, say a month, this can be the average of prior months, or incorporate future months.

For example, a 6-month simple moving average of April 2003 prices would be the average of January 2003 to June 2003 prices. A moving average is commonly used with time series data to smooth out short-term fluctuations and highlight longer-term trends or cycles.

Figure 1. Actual vs. 6-month moving average of coarse rice prices in Bangladesh



Source: Authors' calculations using data from the Department of Agricultural Marketing (DAM).

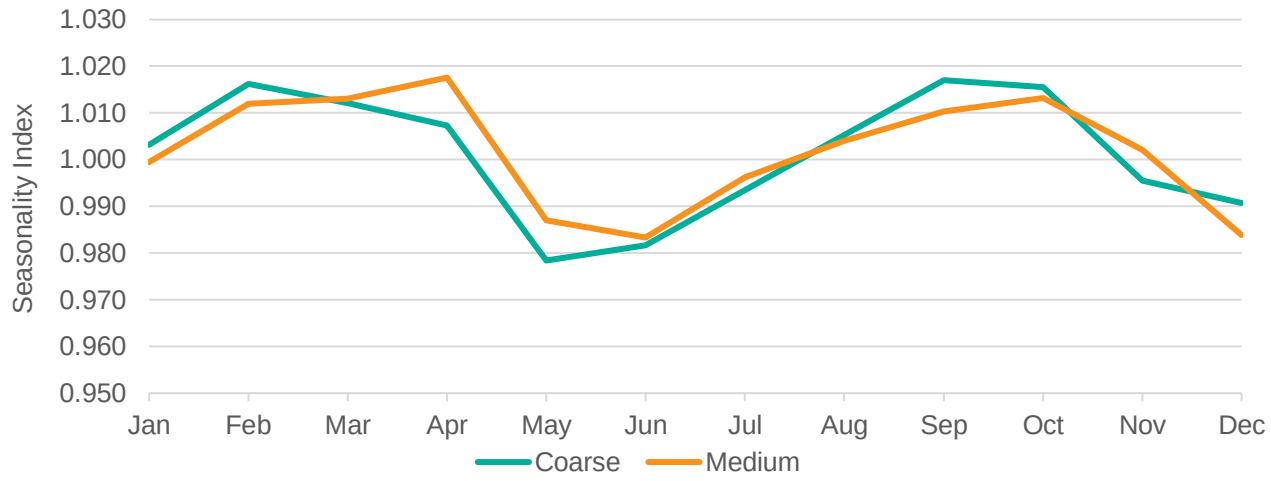
Note: 6MA = 6-month moving average. Note the smoothness of the moving average relative to the actual price curve.

3.1.4 Seasonality

Seasonality is the presence of periodic fluctuations that occur at regular intervals. In a year, there could be seasonality in prices of certain commodities.

Seasonality in the case of agricultural commodity prices is related to harvest periods. Typically, prices are lowest at harvest time, and increase slowly until the next harvest due to storage costs.

Figure 2. Seasonality of coarse and medium rice prices in Bangladesh



Source: Authors' calculations using DAM data.

Note: Note the relative price decrease in harvest months (Nov/Dec for Aman, May/Jun for Boro).

3.2 Module 2: Inflation, CPI and real prices

3.2.1 Defining inflation

Inflation is a general increase in the price level – a proportional increase in ALL prices. It is NOT when an individual price (e.g. fuel) increases.

Inflation is usually caused by excessive growth in the money supply and/or rapid growth in credit, which causes the value of the currency to decline.

3.2.2 Measuring inflation using the Consumer Price Index (CPI)

We measure inflation using the Consumer Price Index (CPI). The CPI is the average price level relative to a base period (base month or base year):

$$CPI(t) = \frac{C(t)}{C(base)} \times 100$$

where, $\mathrm{CPI(t)}$ = consumer price index in current period,
$\mathrm{C(t)}$ = cost of market basket in current period, and
$C(base)$ = cost of market basket in base period.

In Bangladesh, the cost of the market basket is calculated using data from the Household Income and Expenditure Survey (HIES). The current base year used by the BBS for the CPI is 2005-06. Inflation is measured using the percentage difference in the CPI between two periods. For example, in Bangladesh:

- May 2022 ➔ Food CPI (base: 2005-06) = 334.02
- May 2021 ➔ Food CPI (base: 2005-06) = 308.41

The point-to-point food inflation between the two periods is:

$$\left(\frac{CPI(May\ 2022)}{CPI(May\ 2021)}\right) - 1 \times 100 = \frac{334.02}{308.41} - 1 \times 100 = 8.30\%$$

3.2.3 Using the CPI to calculate real prices

What we observe in the market is the nominal price (e.g., the wholesale and retail prices for commodities), which reflects current monetary values.

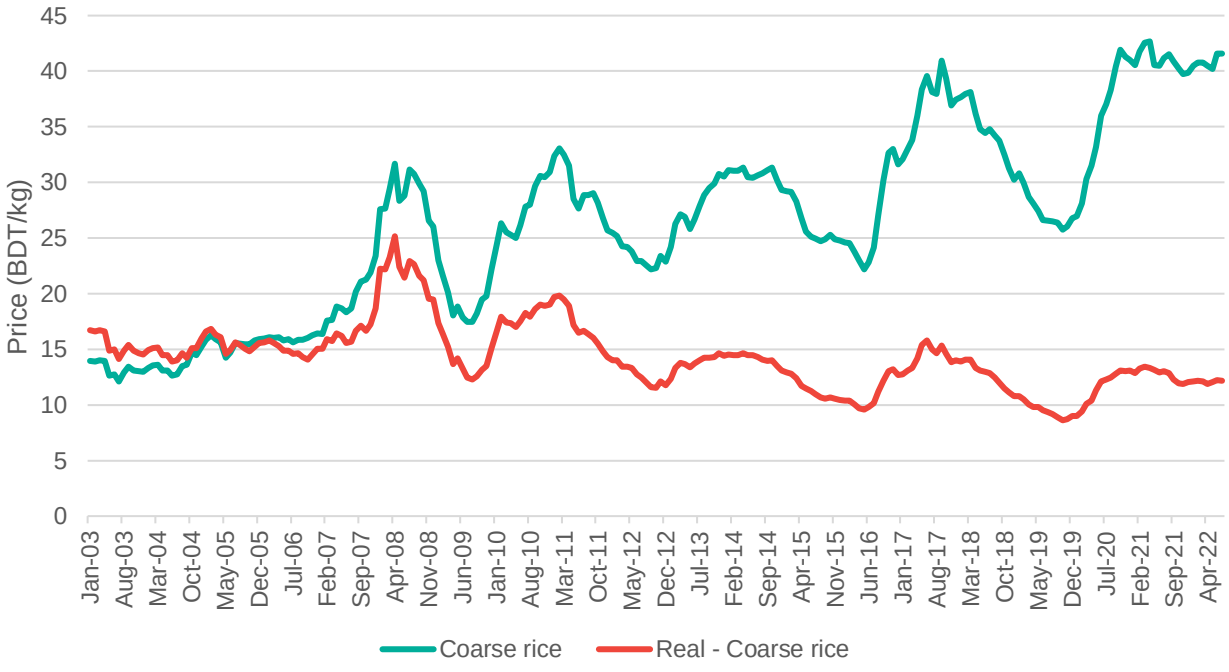
Real prices, on the other hand, are adjusted for inflation and are used to compare prices over time. The real price is calculated as follows:

$$Real\ price = \frac{Nominal\ price}{CPI\ in\ same\ month/100}$$

For example, the wholesale price of coarse rice in January 2022 was BDT 40.48/kg. The real price (base = 2005-06) is:

$$Real\ price = \frac{40.48}{333.51/100} = BDT\ 12.41/kg$$

Figure 3. Nominal and real wholesale coarse rice prices in Bangladesh, 2003-present



Source: Authors' calculations using DAM data.

Note: Note that real prices tend to stay relatively flat (or, in this case, decline) over time.

Nominal prices tend to rise with inflation, while real prices stay relatively "flat". Nominal and real prices cross in the base year (2005-06). The real price is a better indication of incentives to produce or consume.

3.2.4 GDP deflator

In economics, the GDP deflator is a measure of the level of prices of all new, domestically produced, final goods and services in an economy in a year.

Recall that the gross domestic product (GDP) is the total monetary value of all final goods and services produced within the territory of a country over a particular period (quarterly or annually).

Like the CPI, the GDP deflator is a measure of price inflation/deflation with respect to a specific base year; the GDP deflator of the base year itself is equal to 100.

Unlike the CPI, the GDP deflator is not based on a fixed basket of goods and services; the "basket" for the GDP deflator is allowed to change from year to year with people's consumption and investment patterns.

$$\text{GDP deflator} = \frac{\text{Nominal GDP}}{\text{Real GDP}} \times 100$$

3.3 Module 3: Theoretical principles behind the price projection model

3.3.1 The goal: Obtaining projection estimates of prices

The principal objective of the projection method is to obtain projection estimates of prices of key commodities. The training and related demonstrations will focus on coarse and medium rice prices.

If we have data from July 2022 (and before), we want to estimate the price of rice in August, September and October 2022 (the next three months).

According to micro-economic theory, in a competitive market, this July price takes into account all available information on market conditions and expectations.

But we do not necessarily expect the price to stay the same. Several factors could cause prices to change including unexpected shocks to supply (due to weather or pests) or demand (such as the outbreak of Covid).

3.3.2 Drivers of price changes

Other drivers of price changes (in addition to supply and demand shocks) are easier to predict. These include the following:

- **Overall macro-economic inflation:** On average, all prices in the economy are increasing. This is largely determined by macro-economic (exchange rate, fiscal and monetary) policies.
- **Seasonality:** Typically, prices are lowest at harvest time and rise steadily until the next harvest due to the cost of storage.
- **Ramadan:** In Ramadan, people eat certain items of food in larger quantities (e.g., sugar, lentils, oil, etc.). As a result, prices of those goods increase during Ramadan. Typically, these prices decline again after Eid.

3.3.3 The projection model

The model we will be utilizing to project prices over a period of a few months is as follows:

$$PP_{t+1} = P_t \times \frac{sf_{t+1}}{sf_t} \times Inf_{t+1} \times RF_{t+1}$$

where, PP_{t+1} : projected price for period t+1

P_t : actual price in period t

t : the current period; July 2022 in our example

$t+1$: the next period; August 2022 in our example

$\frac{sf_{t+1}}{sf_t}$: seasonality factor

sf_{t+1} : seasonality index for period t+1

sf_t : seasonality index for period t

Inf_{t+1} : rate of inflation for period t+1

RF_{t+1} : Ramadan Factor for period t+1

3.3.4 Estimating the model parameters

Actual price in period, P_t

We have the P_t , the actual price in a given period. In our example, it is the price observed in July 2022. Current prices for each month are available from the Department of Agricultural Marketing (DAM). As this is going to be a monthly model, we will use the monthly national average wholesale price collected from DAM.

Seasonality factor, $\frac{sf_{t+1}}{sf_t}$

As stated before, August prices could be different from July prices. We need to measure the "seasonality factor" by comparing August 2022 prices with July 2022 prices.

However, we only have information on actual prices in July 2022; August 2022 is still to come. Therefore, we use what we know: we use July and August prices from a previous period.

The question now becomes: Which year do we select? Can we use July 2021 and August 2021? The answer is no: recall that 2021 was a special year on account of the Covid-19 pandemic. The same holds for 2020.

Because any year can be a special year, we do not use July and August prices from a particular year. Rather we use **indexes** for July and August prices constructed with years and years of data; 10 years (120 months) 15 years (180 months), 20 years (240 months) or something similar.

Time series data, especially price data can show a lot of ups and downs, known as **volatility**, from month to month. This volatility may persist even when the monthly data are averaged. Therefore, we construct seasonality indexes for each month.

In our example, we'll need to construct seasonality indexes for July (the current period) and August (the projection period) and obtain the seasonality factor by dividing one with the other. This requires a clear understanding of the concepts of indexes and moving averages.

Inflation, Inf_{t+1}

With regards to inflation, we need to know how general prices would increase in August 2022. However, this is not possible since August 2022 has yet to pass. So, we use inflation data from the previous year, i.e., from 2021.

Ramadan factor, RF_{t+1}

We now need to calculate how prices in Ramadan months differ on average to prices in the previous (non-Ramadan) month. If August 2022 is not a Ramadan month, the Ramadan Factor will not make a difference, and RF_{t+1} will have a value of 1. However, if August 2022 is a Ramadan month, RF_{t+1} will have a different value. We will therefore calculate this number.

3.3.5 Important concepts: Moving averages of prices

We use historical monthly data for calculating the seasonality factor. However, monthly price data can be volatile.

Assume that the price of rice in August 2008 is very high relative to the price in July 2008 on account of floods in Sylhet. But in September 2008, rice prices fell because of extra supplies.

If we use actual monthly price data from July 2008 and August 2008, there would be large variations in price from month to month. Importantly, the variations would not be happening every year but only some of the time.

We want to get rid of such wide variations. We do so by dividing the monthly data by its 6-month average, also known as the moving average.

3.4 Module 4: Spreadsheet instructions for generating projection estimates

The following instructions have also been compiled in the **"Training Manual on Spreadsheet Calculations of Projected Prices"**. Here, we reiterate the instructions contained within the manual.

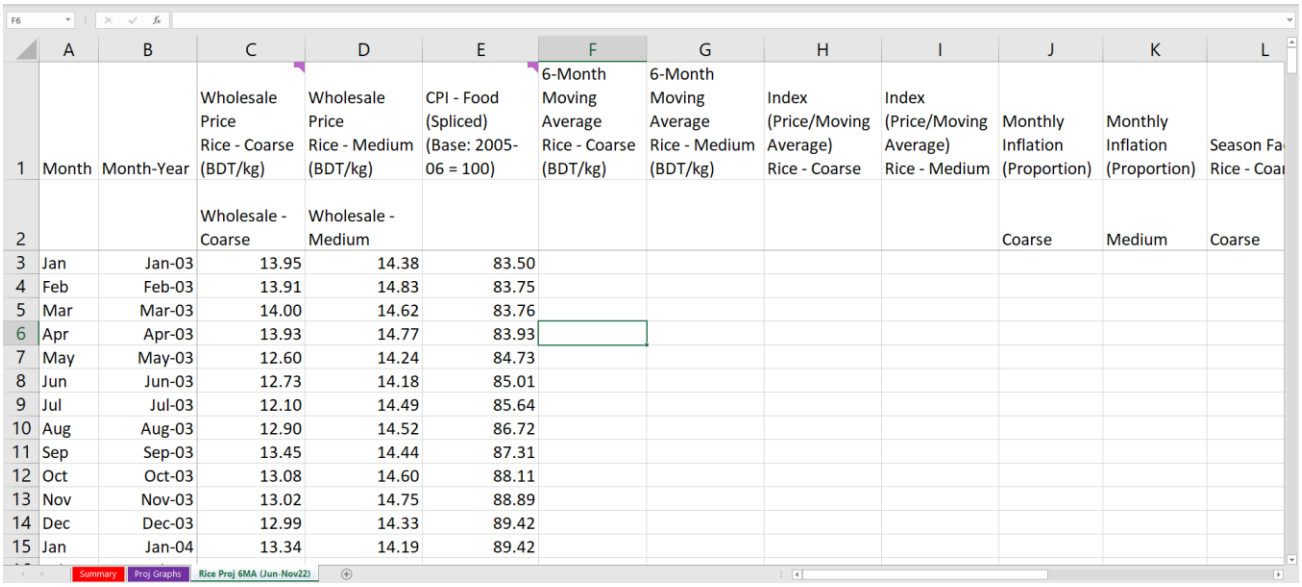
3.4.1 Spreadsheet file, worksheets, and layout

The file we will be working with over the course of the training is the **"Price Projections_Training.xlsx"** Excel spreadsheet.

The primary function of this file is to generate our rice price projection estimates. This will be calculated in the sheet titled **"Rice Proj 6MA (Jun-Nov22)"**.

Upon opening this sheet, you will notice that the data in the sheet are arranged in a time series format. Essentially, this means that each row represents the data for a particular month, while the columns indicate our variables of interest.

Figure 4. Layout of price projection worksheet



	A	B	C	D	E	F	G	H	I	J	K	L
1	Month	Month-Year	Wholesale Price Rice - Coarse (BDT/kg)	Wholesale Price Rice - Medium (BDT/kg)	CPI - Food (Spliced) (Base: 2005-06 = 100)	6-Month Moving Average Rice - Coarse (BDT/kg)	6-Month Moving Average Rice - Medium (BDT/kg)	Index (Price/Moving Average) Rice - Coarse	Index (Price/Moving Average) Rice - Medium	Monthly Inflation (Proportion)	Monthly Inflation (Proportion)	Season Fa Rice - Coa
2			Wholesale - Coarse	Wholesale - Medium						Coarse	Medium	Coarse
3	Jan	Jan-03	13.95	14.38	83.50							
4	Feb	Feb-03	13.91	14.83	83.75							
5	Mar	Mar-03	14.00	14.62	83.76							
6	Apr	Apr-03	13.93	14.77	83.93							
7	May	May-03	12.60	14.24	84.73							
8	Jun	Jun-03	12.73	14.18	85.01							
9	Jul	Jul-03	12.10	14.49	85.64							
10	Aug	Aug-03	12.90	14.52	86.72							
11	Sep	Sep-03	13.45	14.44	87.31							
12	Oct	Oct-03	13.08	14.60	88.11							
13	Nov	Nov-03	13.02	14.75	88.89							
14	Dec	Dec-03	12.99	14.33	89.42							
15	Jan	Jan-04	13.34	14.19	89.42							

3.4.2 Price and CPI data

Prices

The first set of variables in this worksheet is on prices. In columns C and D, we have monthly national wholesale prices for coarse and medium rice respectively. These data are collected from the Department of Agricultural Marketing (DAM).

CPI

Next, in column E, we have consumer price index (CPI) data, available from the Bangladesh Bureau of Statistics (BBS) as well as Bangladesh Bank through their monthly releases on price indexes[1] and economic trends[2] respectively. Briefly, the CPI represents the ratio of the price of a consumer basket of goods in the current period relative to the price of the basket in the base period, such that:

$$CPI(t) = \frac{C(t)}{C(base)} \times 100$$

where $CPI(t)$ = consumer price index in current period,
$C(t)$ = cost of market basket in current period, and
$C(base)$ = cost of market basket in base period.

Changes in the CPI across periods determine the rate of inflation in the country.

When generating new projection estimates, both the price and CPI data must be updated for the relevant months.

[1] National Accounting Wing, Bangladesh Bureau of Statistics (BBS). Consumer Price Index (CPI), Inflation Rate and Wage Rate Index in Bangladesh. Available online at: http://bbs.gov.bd/site/page/29b379ff-7bac-41d9-b321-e41929bab4a1/-

[2] Bangladesh Bank. Monthly Economic Trends. Available online at: https://www.bb.org.bd/en/index.php/publication/publictn/3/10

3.4.3 Constructing the necessary indexes and factors

Moving averages

Using the data on rice prices, we will first construct **6-month moving averages** for both coarse and medium varieties, in columns F and G respectively. The moving average works to smoothen short-term fluctuations in the price data, such that we get a better representation of longer-term trends.

For the purposes of this exercise, here we define the 6-month moving average for a given month as the average of the three preceding months, the month in question, and the two months after. For example, the moving average of rice prices for April 2003 would be the average of prices from January to June 2003.

We start by calculating the moving average of coarse rice for the month of April 2003 (**cell F6**). Here, we type in the following:
=AVERAGE(C3:C8)

and press the **ENTER** key.

Figure 5. Formula for 6-month moving average of coarse rice prices

C3 =AVERAGE(C3:C8)

	A	B	C	D	E	F	G
1	Month	Month-Year	Wholesale Price Rice - Coarse (BDT/kg)	Wholesale Price Rice - Medium (BDT/kg)	CPI - Food (Spliced) (Base: 2005-06 = 100)	6-Month Moving Average Rice - Coarse (BDT/kg)	6-Month Moving Average Rice - Medium (BDT/kg)
2			Wholesale - Coarse	Wholesale - Medium			
3	Jan	Jan-03	13.95	14.38	83.50		
4	Feb	Feb-03	13.91	14.83	83.75		
5	Mar	Mar-03	14.00	14.62	83.76		
6	Apr	Apr-03	13.93	14.77	83.93	=AVERAGE(C3:C8)	
7	May	May-03	12.60	14.24	84.73		
8	Jun	Jun-03	12.73	14.18	85.01		
9	Jul	Jul-03	12.10	14.49	85.64		
10	Aug	Aug-03	12.90	14.52	86.72		
11	Sep	Sep-03	13.45	14.44	87.31		

Tip: Instead of typing C3:C8, we could also select the range C3:C8, which covers coarse rice prices from January to June 2003.

We do the same for medium rice in **cell G6**:
=AVERAGE(D3:D8)

Tip: Since this is essentially the same formula as for coarse rice, we could drag or copy the formula over from cell F6 to cell G6.

Now that we have our moving averages for the month of April, we can copy (or drag) the formula for the entire series, **up to March 2022**:

Figure 6. Extend the moving average formula to the entire series (up to March 2022)

	A	B	C	D	E	F	G
1	Month	Month-Year	Wholesale Price Rice - Coarse (BDT/kg)	Wholesale Price Rice - Medium (BDT/kg)	CPI - Food (Spliced) (Base: 2005-06 = 100)	6-Month Moving Average Rice - Coarse (BDT/kg)	6-Month Moving Average Rice - Medium (BDT/kg)
3	Jan	Jan-03	13.95	14.38	83.50		
4	Feb	Feb-03	13.91	14.83	83.75		
5	Mar	Mar-03	14.00	14.62	83.76		
6	Apr	Apr-03	13.93	14.77	83.93	13.52	14.50
7	May	May-03	12.60	14.24	84.73	13.21	14.52
8	Jun	Jun-03	12.73	14.18	85.01	13.04	14.47
9	Jul	Jul-03	12.10	14.49	85.64	12.95	14.44
10	Aug	Aug-03	12.90	14.52	86.72	12.81	14.41
11	Sep	Sep-03	13.45	14.44	87.31	12.88	14.50

Tip: Select cells F6 and G6. Then, drag the small cross-hair symbol **(+)** *at the corner of cell G6, up to March 2022.*

The reason why we stop at March 2022 is that, since our price data is currently available up to May 2022, selecting up to May would incorporate 2 “blank” price months in the 6-month moving average (which counts 3 months in reverse and 2 months forward).

Index of price to moving average

The next step is to create an index of the actual price to the moving average. This will be used in our calculation of the seasonality factor in later steps. This index is calculated as the actual price of rice in a month divided by the moving average price of rice for that month.

For coarse rice, we type the following into **cell H6**:
=AVERAGE(C6/F6)

and press **ENTER**.

For medium rice, we repeat the above calculation as follows in **cell I6**:
=AVERAGE(D6/G6)

Figure 7. Calculation of index of actual price to the moving average

	A	B	C	D	E	F	G	H	I
1	Month	Month-Year	Wholesale Price Rice - Coarse (BDT/kg)	Wholesale Price Rice - Medium (BDT/kg)	CPI - Food (Spliced) (Base: 2005-06 = 100)	6-Month Moving Average Rice - Coarse (BDT/kg)	6-Month Moving Average Rice - Medium (BDT/kg)	Index (Price/Moving Average) Rice - Coarse	Index (Price/Moving Average) Rice - Medium
3	Jan	Jan-03	13.95	14.38	83.50				
4	Feb	Feb-03	13.91	14.83	83.75				
5	Mar	Mar-03	14.00	14.62	83.76				
6	Apr	Apr-03	13.93	14.77	83.93	13.52	14.50	=C6/F6	
7	May	May-03	12.60	14.24	84.73	13.21	14.52		
8	Jun	Jun-03	12.73	14.18	85.01	13.04	14.47		
9	Jul	Jul-03	12.10	14.49	85.64	12.95	14.44		
10	Aug	Aug-03	12.90	14.52	86.72	12.81	14.41		
11	Sep	Sep-03	13.45	14.44	87.31	12.88	14.50		
12	Oct	Oct-03	13.08	14.60	88.11	12.92	14.52		
13	Nov	Nov-03	13.02	14.75	88.89	13.13	14.47		
14	Dec	Dec-03	12.99	14.33	89.42	13.24	14.46		
15	Jan	Jan-04	13.34	14.19	89.42	13.27	14.48		

Just as we did for moving averages, we now extend this index to March 2022.

Figure 8. Extend the index formula to the entire series (up to March 2022)

	A	B	C	D	E	F	G	H	I
1	Month	Month-Year	Wholesale Price Rice - Coarse (BDT/kg)	Wholesale Price Rice - Medium (BDT/kg)	CPI - Food (Spliced) (Base: 2005-06 = 100)	6-Month Moving Average Rice - Coarse (BDT/kg)	6-Month Moving Average Rice - Medium (BDT/kg)	Index (Price/Moving Average) Rice - Coarse	Index (Price/Moving Average) Rice - Medium
3	Jan	Jan-03	13.95	14.38	83.50				
4	Feb	Feb-03	13.91	14.83	83.75				
5	Mar	Mar-03	14.00	14.62	83.76				
6	Apr	Apr-03	13.93	14.77	83.93	13.52	14.50	1.030	1.018
7	May	May-03	12.60	14.24	84.73	13.21	14.52	0.954	0.981
8	Jun	Jun-03	12.73	14.18	85.01	13.04	14.47	0.976	0.980
9	Jul	Jul-03	12.10	14.49	85.64	12.95	14.44	0.934	1.003
10	Aug	Aug-03	12.90	14.52	86.72	12.81	14.41	1.007	1.008
11	Sep	Sep-03	13.45	14.44	87.31	12.88	14.50	1.044	0.996
12	Oct	Oct-03	13.08	14.60	88.11	12.92	14.52	1.012	1.005
13	Nov	Nov-03	13.02	14.75	88.89	13.13	14.47	0.992	1.019
14	Dec	Dec-03	12.99	14.33	89.42	13.24	14.46	0.981	0.991

Annual inflation

Now, we need to calculate the annual inflation for two years: 2020 and 2021. From this, we will calculate the monthly effect of inflation distributed over each of the 12 months in a year.

For a given year, the point-to-point inflation is calculated as the percentage difference between the CPI in a given month and the CPI for the same month in the previous year. For example, the 2020 inflation rate is calculated as follows:

$$Inflation_{2020} = \frac{CPI_{December\ 2020}}{CPI_{December\ 2019}} - 1$$

Note: This can be expressed in percentage terms by multiplying the result by 100.

In our file, we will now move to the bottom of the worksheet, in the highlighted cells titled 'Inflation' (**cell I245**). Here, we will calculate the annual inflation for the years 2020 and 2021.

For 2020 inflation, we will type the following in **cell I245**:
=$E$218/$E$206-1

This calculates the difference between the CPI in December 2020 (in **cell E218**) and December 2019 (**cell E206**), expressed as a fraction.

Figure 9. Calculation of annual inflation

	A	B	E	F	G	H	I	J	K
1	Month	Month-Year	CPI - Food (Spliced) (Base: 2005-06 = 100)	6-Month Moving Average Rice - Coarse (BDT/kg)	6-Month Moving Average Rice - Medium (BDT/kg)	Index (Price/Moving Average) Rice - Coarse	Index (Price/Moving Average) Rice - Medium	Monthly Inflation (Proportion)	Monthly Inflation (Proportion)
239	Sep	Sep-22							
240	Oct	Oct-22							
241	Nov	Nov-22							
242	Dec	Dec-22							
243									
244						Inflation			
245						Y2020	=$E$218/$E$206-1		
246						Y2021			

Likewise, we do the same for 2021 in **cell I246**:
=$E$230/$E$218-1

Note that the values have been copied over on to the adjacent cells in columns J and K for ease of use in the next section.

Tip: Using "$" symbols 'fixes' the cells, such that if the formula is copied over to another part of the sheet, the cell reference will remain the same.

Monthly inflation (as a proportion of annual inflation)

Next, we need to distribute the annual inflation over a period of 12 months. We do this in order to minimize the variability of monthly inflation on the projected price series. To do this in our file, we type the following into **cell J207**:
=(1+$J$245)^(1/12)

This takes the annual inflation figure for 2020 we calculated earlier in cell J245 and applies it to the month of January 2020. Likewise, we do the same for medium rice in **cell K207**:
=(1+$K$245)^(1/12)

We can now copy over the formulas all the way to the end of 2020 as below:

Figure 10. Monthly inflation series for 2020

	A	B	I	J	K
1	Month	Month-Year	Index (Price/Moving Average) Rice - Medium	Monthly Inflation (Proportion)	Monthly Inflation (Proportion)
207	Jan	Jan-20	0.979	1.004346	1.004346
208	Feb	Feb-20	0.975	1.004346	1.004346
209	Mar	Mar-20	1.008	1.004346	1.004346
210	Apr	Apr-20	1.060	1.004346	1.004346
211	May	May-20	1.011	1.004346	1.004346
212	Jun	Jun-20	1.035	1.004346	1.004346
213	Jul	Jul-20	1.016	1.004346	1.004346
214	Aug	Aug-20	1.010	1.004346	1.004346
215	Sep	Sep-20	1.013	1.004346	1.004346
216	Oct	Oct-20	1.033	1.004346	1.004346
217	Nov	Nov-20	1.018	1.004346	1.004346
218	Dec	Dec-20	0.993	1.004346	1.004346

We repeat the same for the months of 2021, starting in **cell J219**:
=(1+$J$246)^(1/12)

Copying the formulas to the end of 2021 reveals the monthly inflation series below:

Figure 11. Monthly inflation series for 2021

	A	B	I	J	K
1	Month	Month-Year	Index (Price/Moving Average) Rice - Medium	Monthly Inflation (Proportion)	Monthly Inflation (Proportion)
219	Jan	Jan-21	0.991	1.004439	1.004439
220	Feb	Feb-21	1.003	1.004439	1.004439
221	Mar	Mar-21	1.024	1.004439	1.004439
222	Apr	Apr-21	1.046	1.004439	1.004439
223	May	May-21	0.980	1.004439	1.004439
224	Jun	Jun-21	0.970	1.004439	1.004439
225	Jul	Jul-21	0.995	1.004439	1.004439
226	Aug	Aug-21	1.015	1.004439	1.004439
227	Sep	Sep-21	1.006	1.004439	1.004439
228	Oct	Oct-21	0.996	1.004439	1.004439
229	Nov	Nov-21	0.998	1.004439	1.004439
230	Dec	Dec-21	0.985	1.004439	1.004439

Since 2022 is still ongoing, we assume the annual inflation rate for 2021 for the same months of 2022. Note that in practice, however, this would be updated once the CPI series for all of 2022 is available.

Seasonality factor

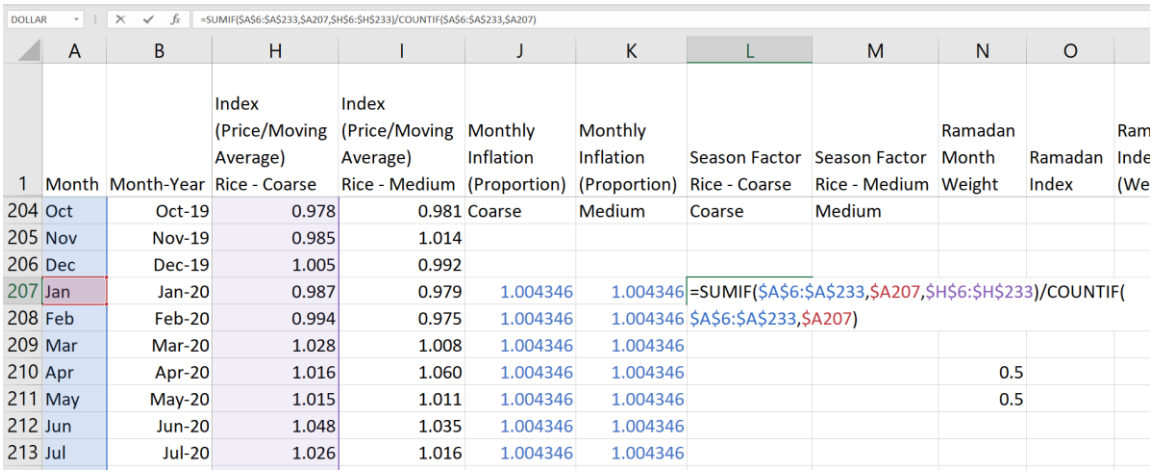
Now, we calculate the seasonality factor for coarse and medium rice. Essentially, seasonality is an expression of the price movement in a given month relative to the average price. To construct this factor, we will use the index of the actual price to the 6-month moving average we generated earlier.

We start with the month of January. The seasonality index for January is the average of all the price indexes for all the January months in the entire series. We will therefore need to sum all the January indexes, and then divide by the number of January months in the entire series.

To do this for coarse rice, we type the following in **cell L207**:
=SUMIF($A$6:$A$233, $A207, $H$6:$H$233)/COUNTIF($A$6:$A$233, $A207)

Here, we use the SUMIF and COUNTIF functions. The SUMIF function is working to add up all the indexes (in column H) for all the months of January in the series. In the first part of the SUMIF function, we specify the range of the condition (i.e., the range of months in column A). Next, we specify the month of interest (in this case, January). The last part of the SUMIF function specifies the summation range (i.e., the range of indexes in column H). We then use the COUNTIF function to count the number of times the month January shows up in the month series. Like SUMIF, the first part of the COUNTIF function specifies the range of the condition (i.e., the range of months in column A) and the second specifies the month (January). We can now do the same for medium rice in **cell M207**:
=SUMIF($A$6:$A$233, $A207, $I$6:$I$233)/COUNTIF($A$6:$A$233, $A207)

Figure 12. Calculation of seasonality factor



DOLLAR | =SUMIF($A$6:$A$233,$A207,$H$6:$H$233)/COUNTIF($A$6:$A$233,$A207)

	A	B	H	I	J	K	L	M	N	O	
1	Month	Month-Year	Index (Price/Moving Average) Rice - Coarse	Index (Price/Moving Average) Rice - Medium	Monthly Inflation (Proportion)	Monthly Inflation (Proportion)	Season Factor Rice - Coarse	Season Factor Rice - Medium	Ramadan Month Weight	Ramadan Index	Ram Inde (We
204	Oct	Oct-19	0.978	0.981	Coarse	Medium	Coarse	Medium			
205	Nov	Nov-19	0.985	1.014							
206	Dec	Dec-19	1.005	0.992							
207	Jan	Jan-20	0.987	0.979	1.004346	1.004346	=SUMIF($A$6:$A$233,$A207,$H$6:$H$233)/COUNTIF(				
208	Feb	Feb-20	0.994	0.975	1.004346	1.004346	$A$6:$A$233,$A207)				
209	Mar	Mar-20	1.028	1.008	1.004346	1.004346					
210	Apr	Apr-20	1.016	1.060	1.004346	1.004346			0.5		
211	May	May-20	1.015	1.011	1.004346	1.004346			0.5		
212	Jun	Jun-20	1.048	1.035	1.004346	1.004346					
213	Jul	Jul-20	1.026	1.016	1.004346	1.004346					

We can then copy over the calculated seasonality factor for the rest of the series.

Ramadan factor

Our final step prior to generating the projections is to calculate the Ramadan factor. Through this factor, we are trying to account for price deviations from the general trend due to Ramadan.

In column N, we have indicated the months during which Ramadan has fallen in the entire series and assigned a weight for those months. If Ramadan was almost entirely contained within one calendar month, the weight is 1. If Ramadan falls across two months, we distribute the weight equally across both months. For example, in 2021, Ramadan was in April and May, so we assign 0.5 as the weight in each of the two months.

The next step is to have an index of the Ramadan price increase relative to its preceding month. In **cell O222**, we type in the following:
=C222/C221

This is a simple ratio of the price in April 2021 (the first month of Ramadan in 2021) to the price in March, and we refer to it as the Ramadan index. We then apply the Ramadan weight to this index to distribute the effect of the price over the Ramadan months in **cell P222**:
=O222*N222

We can now copy over the formulas for May 2021 (**cells O223 and P223**) for April 2022 (**cells O234 and P234**). Note that in 2022, Ramadan was almost entirely contained within the month of April.

Figure 13. Ramadan weights and indexes

	A	B	N	O	P
1	Month	Month-Year	Ramadan Month Weight	Ramadan Index	Ramadan Index (Weighted)
223	May	May-21	0.5	0.950	0.475
224	Jun	Jun-21			
225	Jul	Jul-21			
226	Aug	Aug-21			
227	Sep	Sep-21			
228	Oct	Oct-21			
229	Nov	Nov-21			
230	Dec	Dec-21			
231	Jan	Jan-22			
232	Feb	Feb-22			
233	Mar	Mar-22			
234	Apr	Apr-22	1	0.993	0.993

The final step in this section is to calculate the Ramadan factor. Similar to the seasonality factor, this will be a sum of all the weighted Ramadan indexes over the total number of Ramadan months up to the most recent Ramadan period. In **cell Q222**, we type in the following to get the Ramadan factor for April 2021:
=SUM($P$3:$P$211)/SUM($N$3:$N$211)

Note that we stop at row 211 as this is the most recently elapsed Ramadan period. We can now copy over the formula for May in **cell Q223**.

For 2022, we expand the formula range to capture the Ramadan effect of 2021 and type the following in **cell Q234**:
=SUM($P$3:$P$223)/SUM($N$3:$N$223)

Figure 14. Calculation of Ramadan factor

	A	B	N	O	P	Q	R	S	T
1	Month	Month-Year	Ramadan Month Weight	Ramadan Index	Ramadan Index (Weighted)	Ramadan Factor	Projected Price Rice - Coarse (BDT/kg)	Projected Price Rice - Medium (BDT/kg)	Squarec Error
211	May	May-20	0.5	1.053	0.526				
212	Jun	Jun-20							
213	Jul	Jul-20							
214	Aug	Aug-20							
215	Sep	Sep-20							
216	Oct	Oct-20							
217	Nov	Nov-20							
218	Dec	Dec-20							
219	Jan	Jan-21							
220	Feb	Feb-21							
221	Mar	Mar-21							
222	Apr	Apr-21	0.5	1.003	0.501	1.011			
223	May	May-21	0.5	0.950	0.475	1.011			
224	Jun	Jun-21							
225	Jul	Jul-21							
226	Aug	Aug-21							
227	Sep	Sep-21							
228	Oct	Oct-21							
229	Nov	Nov-21							
230	Dec	Dec-21							
231	Jan	Jan-22							
232	Feb	Feb-22							
233	Mar	Mar-22							
234	Apr	Apr-22	1	0.993	0.993	=SUM($P$3:$P$223)/SUM($N$3:$N$223)			

3.4.4 Generating the price projections

Since we have actual price data up to May 2022, we will first generate a set of projections for the next 6 months – covering June to November 2022.

Recall the **price projection formula** discussed in the lectures:

$$PP(t+1) = P(t) \times \frac{sf(t+1)}{sf(t)} \times inf(t+1) \times RF(t+1)$$

- $PP(t+1)$ = projected price in period t+1 (i.e., the coming month),
- $P(t)$ = actual or projected price in period t (i.e., the current month),
- $sf(t+1)$ = seasonal factor for the month of period t+1, estimated from historical data,
- $inf(t+1)$ = monthly rate of inflation, calculated using data from the most recent CPI data for the previous year, and
- $RF(t+1)$ = Ramadan adjustment factor, calculated as the average price increase relative to seasonally adjusted trend

The first component of the projection is the actual price in month t – in our case, this is the month of May 2022.

In cells R235 and S235 (highlighted in yellow), we are going to input the actual prices of coarse and medium rice for those months, respectively:
=C235 (in cell R235 for coarse rice)
=D235 (in cell S235 for medium rice)

The first month for the projection is June 2022. For coarse rice, we will calculate this in cell R236 by implementing the price projection formula as below:
=R235*(L236/L235)*J236*$Q236

Here, we take the actual price of coarse rice in May (from cell R235), multiply it by the ratio of the seasonality factor for June over that of May (L236/L235), and then multiply by the inflation (J236) and the Ramadan factor (Q236). Note that we have entered 1 for the Ramadan factor in non-Ramadan months, since there is no Ramadan effect in these months.

Figure 15. Calculation of the projected price of coarse rice for June 2022

	A	B	J	K	L	M	N	O	P	Q	R	S	T	
1	Month	Month-Year	Monthly Inflation (Proportion)	Monthly Inflation (Proportion)	Season Factor Rice - Coarse	Season Factor Rice - Medium	Ramadan Month Weight	Ramadan Index	Ramadan Index (Weighted)	Ramadan Factor	Projected Price Rice - Coarse (BDT/kg)	Projected Price Rice - Medium (BDT/kg)	Squared Error	Sq Err
233	Mar	Mar-22	1.004439	1.004439	1.012	1.013								
234	Apr	Apr-22	1.004439	1.004439	1.007	1.018	1	0.993	0.993	1.009				
235	May	May-22	1.004439	1.004439	0.978	0.987				1	40.23	48.44		
236	Jun	Jun-22	1.004439	1.004439	0.982	0.985				1	=R235*(L236/L235)*$J236*$Q236			
237	Jul	Jul-22	1.004439	1.004439	0.993	0.998				1				
238	Aug	Aug-22	1.004439	1.004439	1.005	0.997				1				
239	Sep	Sep-22	1.004439	1.004439	1.017	1.012				1				
240	Oct	Oct-22	1.004439	1.004439	1.016	1.015				1				
241	Nov	Nov-22	1.004439	1.004439	0.996	1.004				1				
242	Dec	Dec-22	1.004439	1.004439	0.991	0.984								

For each of the subsequent months (July to November 2022), the formula will refer to the previous month. We can now copy over the formulas and generate the projection series for July to November and for medium rice.

Figure 16. Projected price series, June to November 2022

	A	B	N	O	P	Q	R	S
1	Month	Month-Year	Ramadan Month Weight	Ramadan Index	Ramadan Index (Weighted)	Ramadan Factor	Projected Price Rice - Coarse (BDT/kg)	Projected Price Rice - Medium (BDT/kg)
233	Mar	Mar-22						
234	Apr	Apr-22	1	0.993	0.993	1.009		
235	May	May-22				1	40.23	48.44
236	Jun	Jun-22				1	40.54	48.54
237	Jul	Jul-22				1	41.21	49.39
238	Aug	Aug-22				1	41.88	49.57
239	Sep	Sep-22				1	42.56	50.54
240	Oct	Oct-22				1	42.69	50.91
241	Nov	Nov-22				1	42.03	50.57

3.4.5 Confidence intervals

Replicating projections for the same months in a previous period

The final step after generating the projection estimates is to gauge an idea of how good these projections are. To do this, we need to be able to compare these estimates to actual prices in a period.

However, we do not have actual prices for June to November 2022, since these months have yet to occur. We therefore compare the "goodness of fit" of these estimates by replicating the projections for a previous period for which we do have actual price data. Since the projections cover the months of June to November 2022, we can replicate them for the same period in 2021 and then calculate the squared errors.

First, we input the actual prices of coarse and medium rice in cells **R223 and S223**:
=C223 (in cell R223 for coarse rice)
=D223 (in cell S223 for medium rice)

Now, the first month for the projection is June 2021. We input the projection formula in cell R224 as below:
=R223*(L224/L223)*J224*$Q224

and copy over the formula to the adjacent cells in column S to generate the projection series up to November 2021.

Figure 17. Projected price series, June to November 2021

	A	B	N	O	P	Q	R	S
1	Month	Month-Year	Ramadan Month Weight	Ramadan Index	Ramadan Index (weighted)	Ramadan Factor	Projected Price Rice - Coarse (BDT/kg)	Projected Price Rice - Medium (BDT/kg)
221	Mar	Mar-21				1		
222	Apr	Apr-21	0.5	1.003	0.501	1.011		
223	May	May-21	0.5	0.950	0.475	1.011	40.55	47.17
224	Jun	Jun-21				1	40.87	47.20
225	Jul	Jul-21				1	41.54	48.03
226	Aug	Aug-21				1	42.22	48.63
227	Sep	Sep-21				1	42.91	49.15
228	Oct	Oct-21				1	43.03	49.51
229	Nov	Nov-21				1	42.37	49.18

Calculating squared errors

Next, we calculate the **squared errors** between these projected prices and the actual prices for the same month. Recall that earlier, we learned about the variance, which is the average of squared errors. What we are now calculating is the first component of the variance, the squared error term. This gives us an idea of how far the projection estimate for a given month is from the actual observed price in that month.

To do this, we type the following in **cell T224**:
=(C224-R224)^2

and copy over the formula for the adjacent cells in column S up to November 2021.

Figure 18. Squared errors for projected prices relative to actual prices, June to November 2021

	A	B	N	O	P	Q	R	S	T	U
1	Month	Month-Year	Ramadan Month Weight	Ramadan Index	Ramadan Index (weighted)	Ramadan Factor	Projected Price Rice - Coarse (BDT/kg)	Projected Price Rice - Medium (BDT/kg)	Squared Error	Squared Error
2							Projected - Coarse	Projected - Medium	Squared Error (Coarse)	Squared Error (Medium)
219	Jan	Jan-21								
220	Feb	Feb-21								
221	Mar	Mar-21								
222	Apr	Apr-21	0.5	1.003	0.501	1.011				
223	May	May-21	0.5	0.950	0.475	1.011	40.55	47.17		
224	Jun	Jun-21				1	40.87	47.20	0.139	0.207
225	Jul	Jul-21				1	41.54	48.03	0.150	0.128
226	Aug	Aug-21				1	42.22	48.63	0.503	0.264
227	Sep	Sep-21				1	42.91	49.15	4.156	2.164
228	Oct	Oct-21				1	43.03	49.51	7.797	5.740
229	Nov	Nov-21				1	42.37	49.18	7.048	4.491

Mean squared errors, standard deviations, and confidence levels

We will now calculate the mean of these squared errors[3] and use this to calculate the standard deviation of the projection estimates for June to November 2021.

In **cells T246 and U246**, we calculate the mean squared errors of the projected rice prices as follows:
=AVERAGE(T224:T229)
=AVERAGE(U224:U229)

Taking the square root of these values gives us the standard deviation:
=T246^0.5 (in cell T247)
=U246^0.5 (in cell U247)

Next, we calculate the true means of actual coarse and medium rice prices in **cells T248 and U248**:
=AVERAGE(C224:C229)
=AVERAGE(D224:D229)

Finally, we are going to calculate the 90% confidence intervals (90% CI) for our projection estimates for the period **June to November 2022**. Here, we are assuming that the error in the projection estimates for 2022 would be similar to the level observed in the previous period (June to November 2021).

The 90% CI can be thought of as a range of estimates for an unknown parameter. In simple terms, for all intervals computed at the 90% level, we would expect the parameter's true value to be contained in 90% of these intervals. If we were to repeat the exercise 100 times, we can expect the actual price to be contained within the bounds of the confidence interval of the projected price 90 times.

We can also think of this interval as representing values that are not statistically significantly different from the point estimate at the 10% level.

Note that if we were using other confidence limits (such as 95% or 99%), the range of between the upper and lower bounds of the interval would be larger.

In **cells T249 and U249**, we input the z-value of the 90% CI, which is 1.645.

The formula for calculating the upper and lower bounds of the confidence interval for a mean value is as follows:

$$CI = \bar{x} \pm z\frac{s}{\sqrt{n}}$$

where, CI = confidence interval
$\bar{x}$ = mean
z = z-value of the chosen confidence level
s = the sample standard deviation
n = sample size

In our case, we are not calculating the confidence of the mean price, but rather the confidence interval of each of the projected prices every month. As such, the formula can be adjusted as follows:

[3] The mean squared error considers the deviation of the estimate from the true parameter, whereas the variance measures the deviation from its expected value.

$$CI = x \pm z \times s$$

such that the confidence interval is equal to the point estimate plus (for the upper bound) or minus (for the lower bound) the product of the z-value of the chosen confidence level and the calculated standard deviation of the projected values.

In **cell V235**, we first calculate the lower bound of the 90% CI for our actual projected coarse rice price estimates:
=$R235-($T$247*$T$249)

Similarly, in **cell W235**, we calculate the upper bound:
=$R235+($T$247*$T$249)

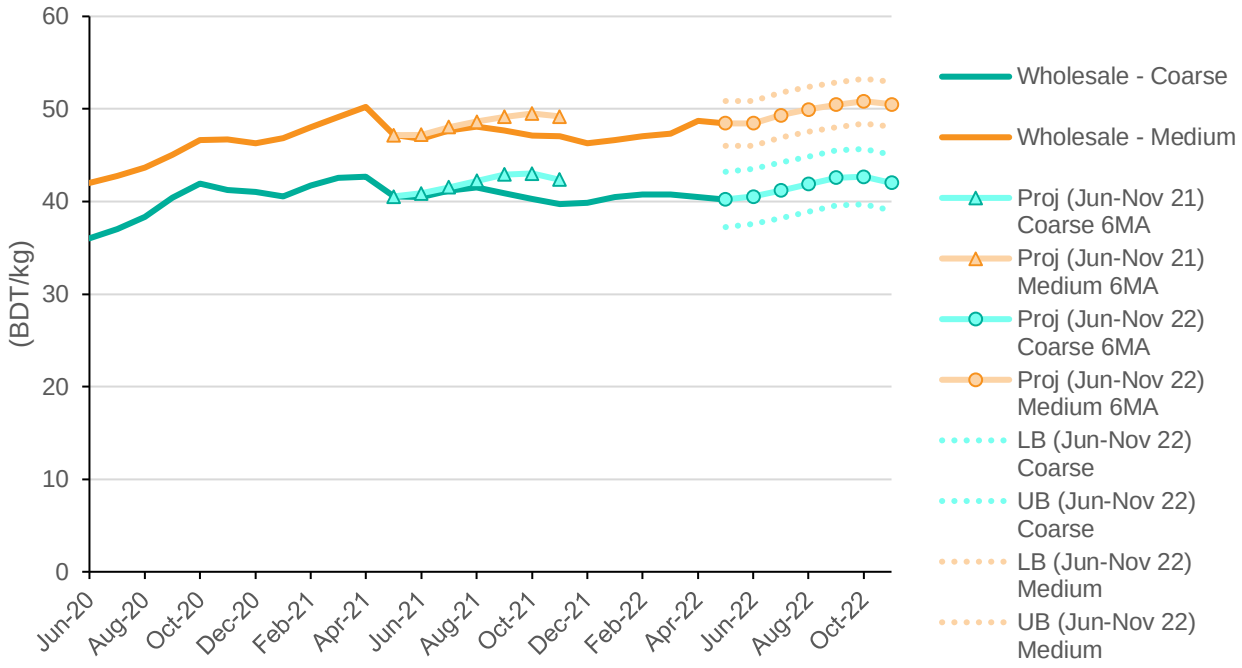
We do the same for medium rice in columns X and Y, and copy the formula for the remaining months up to November 2022 to reveal the confidence interval series below.

Figure 19. 90% confidence intervals for projected prices, June to November 2022

	A	B	R	S	T	U	V	W	X	Y
1	Month	Month-Year	Projected Price Rice - Coarse (BDT/kg)	Projected Price Rice - Medium (BDT/kg)	Squared Error	Squared Error	Lower Bound 2022	Upper Bound 2022	Lower Bound 2022	Upper Bound 2022
2			Projected - Coarse	Projected - Medium	Squared Error (Coarse)	Squared Error (Medium)	LB - Coarse	UB - Coarse	LB - Medium	UB - Medium
231	Jan	Jan-22								
232	Feb	Feb-22								
233	Mar	Mar-22								
234	Apr	Apr-22								
235	May	May-22	40.23	48.44			37.24	43.21	46.02	50.86
236	Jun	Jun-22	40.54	48.47			37.55	43.53	46.05	50.89
237	Jul	Jul-22	41.21	49.32			38.22	44.20	46.90	51.74
238	Aug	Aug-22	41.88	49.93			38.90	44.87	47.51	52.35
239	Sep	Sep-22	42.56	50.46			39.57	45.55	48.04	52.88
240	Oct	Oct-22	42.69	50.84			39.70	45.68	48.42	53.26
241	Nov	Nov-22	42.03	50.50			39.04	45.02	48.08	52.92
242	Dec	Dec-22								
243										
244										
245				**Six months**	**Coarse**	**Medium**				
246				Mean sq eri	3.299	2.166				
247				st dev	1.816	1.472				
248				True mean	40.664	47.397				
249				90% CI	1.645	1.645				

We can now see the actual and projected prices for 2021 and 2022, and the confidence intervals for projected prices in 2022 in the figure below.

Figure 20. Actual and projected prices of wholesale coarse and medium rice, June-November 2021 and June-November 2022



4 SIMULATION ANALYSIS OF SUPPLY, DEMAND AND PRICES

The methodology of price projection covered in the training utilizes the trend in monthly prices over time. However, in the face of sudden shocks to the economy, such as a supply shock (e.g., a natural calamity like a flood), price trends are less useful in projecting future prices.

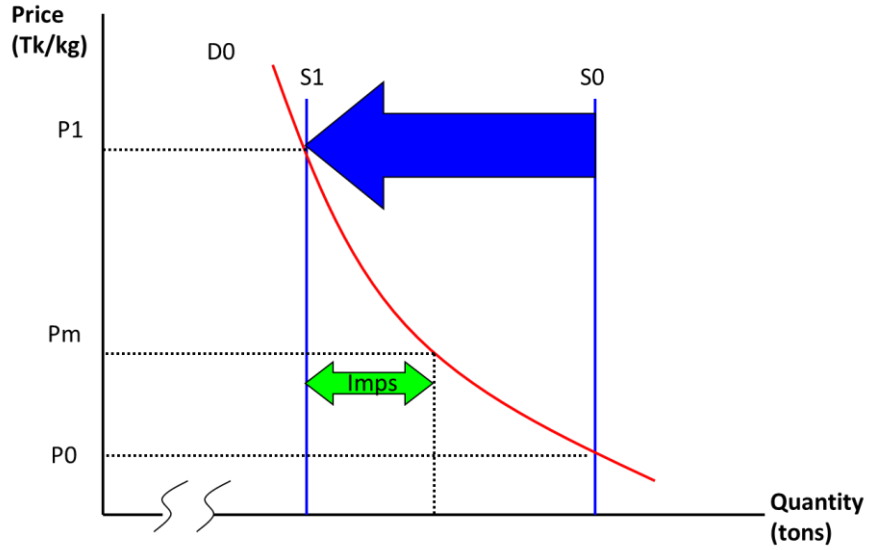
Fortunately, there are useful tools for analyzing potential price movements in the presence of shocks. This section details the final part of the training, which covered analyses of supply, demand and prices, and presents a simplified set of simulations illustrating the short-run effects of supply shocks on prices. The following topics were covered:

- Supply, demand and international trade;
- Import parity, prices and imports; and
- Spreadsheet analysis of shocks with and without private imports.

4.1 Short-run impact of a supply shock

We first look at the short-run impact of a supply shock. In Figure 21 below, we see that, in a normal year, domestic production is at S_0 and price is P_0. In a closed economy, (i.e., with no foreign trade), if supply declines from S_0 to S_1 due to a weather shock, the market price rises to P_1. If there is free trade with an import parity price of P_m, however, then total supply is Q_2 and imports are Q_2-Q_1.

Figure 21. Impact of a supply shock on prices



4.2 Import parity and prices

4.2.1 Import parity calculations (15% broken, May 2022)

The import parity price, P_m, is calculated as follows:

$P_m = (P_{WM} + \text{shipping}) * ER * (1 + t_m) + \text{domestic marketing costs}$

where:

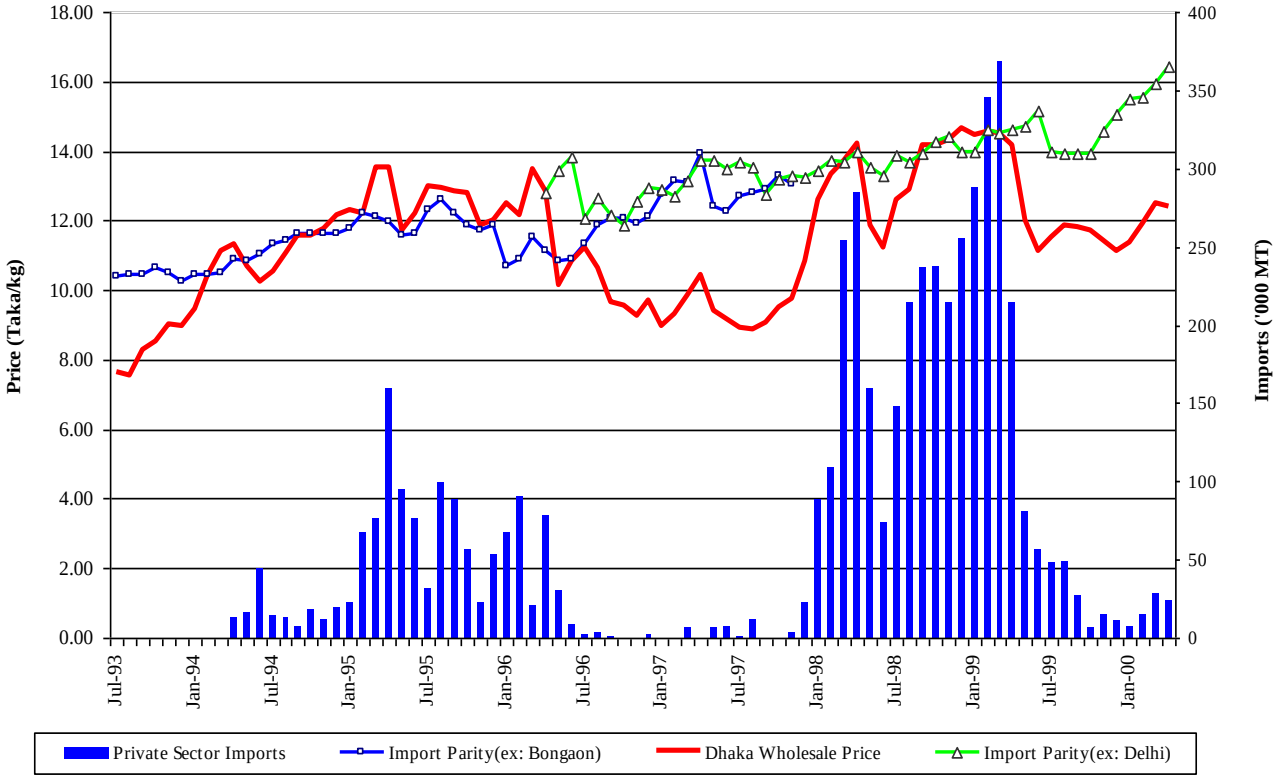
P_{WM} = Export price (fob Bangkok 15%)	$ 461/ton
Shipping = Shipping costs	$ 40/ton (35-45)
ER = Exchange Rate (Tk/USD)	89 Tk/$
P_{CIF} = Import price Chittagong (Tk/kg)	44.6 Tk/kg
t_m = import tariff (25% or 62.5%)	11.1 Tk/kg
P_m = Import parity price Chittagong (Tk/kg)	55.7 Tk/kg
Domestic marketing costs (Chit-Dhaka)	5.8 Tk/kg
P_m = Import parity price Dhaka	61.5 Tk/kg
P_m without import tariff	50.4 Tk/kg
Wholesale price medium quality (national average)	48.4 Tk/kg

4.2.2 Trade liberalization and private sector rice imports: 1994-2000

Bangladesh liberalized its import trade in rice in the early 1990s. In years of relatively poor harvests in the mid- to late-1990s, import parity prices provided a price ceiling for Bangladesh domestic market prices.

Following the 1998 flood, private sector imports exceeded 200 thousand tons/month for seven consecutive months, stabilizing domestic prices at import parity (based on India wholesale market prices plus transport and marketing costs), (Figure 22).

Figure 22. Private sector imports and parity prices of rice in Bangladesh, 1994-2000

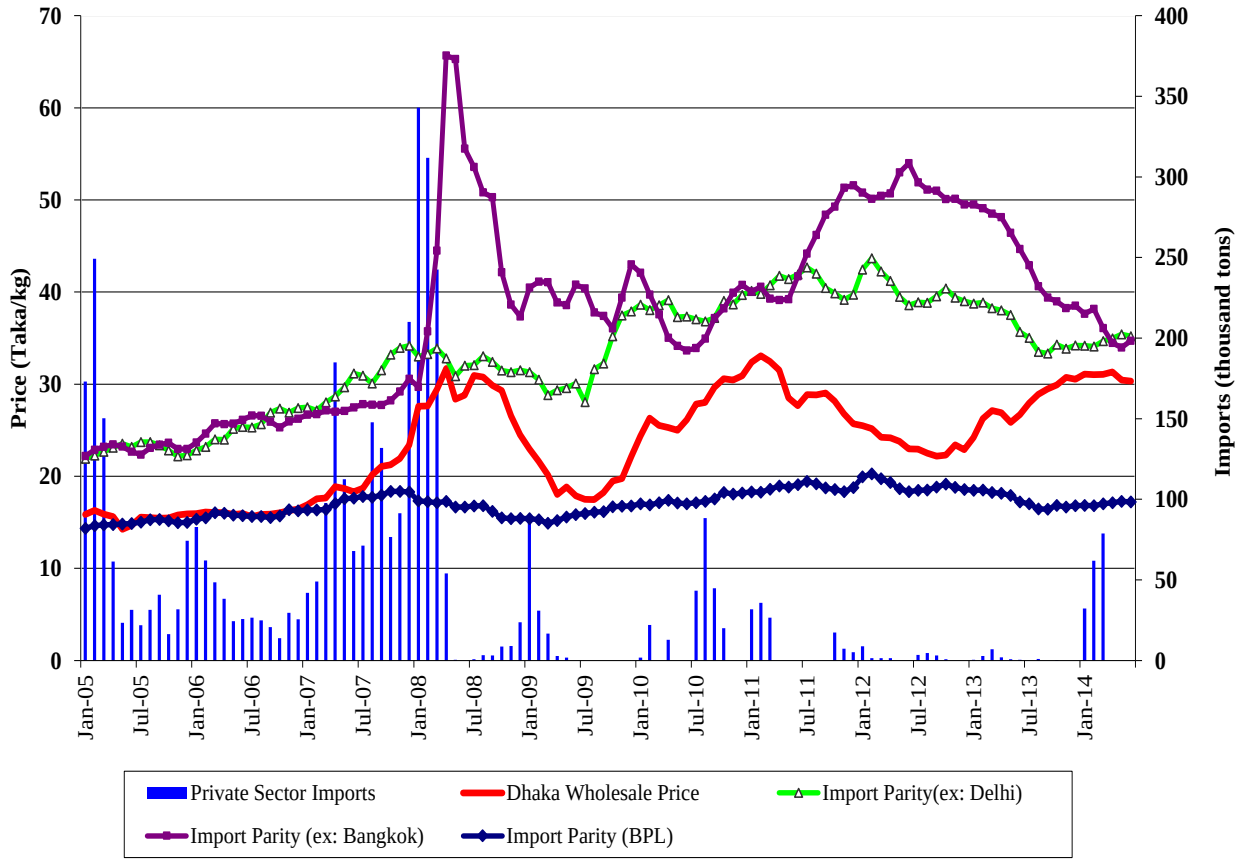


4.2.3 Price stabilization through subsidized trade: 2002/03-2006/07

In 2000/01 and again from 2002/03 to 2006/07, Bangladesh prices tracked import parity based on below poverty line (BPL) sales prices (Figure 23). A specific Indian government program existed in 2002/3 for subsidized exports of rice obtained from FCI stocks at BPL prices.

There were no explicit policy statements regarding export subsidies by the Indian government in later years. Econometric analysis shows that there was a statistically significant co-movement of wholesale and import parity prices of rice from India in this period.

Figure 23. Private sector imports and parity prices of rice in Bangladesh, 2005-2015



4.2.4 The world price shock of 2007/08

In late 2007, world prices of rice and other cereals increased sharply as major exporters cut back export supplies. India initially banned private exports of non-basmati rice, but Bangladesh later negotiated a fixed volume of imports at a set price

Bangladesh private sector imports from August 2007-April 2008 reached 1.6 million tons. Nonetheless, because import parity prices of rice from wholesale markets in India were much higher than the import parity price of BPL rice, domestic prices in Bangladesh rose sharply.

4.2.5 Bangladesh: Import parity and wholesale prices of rice, 2010-2022

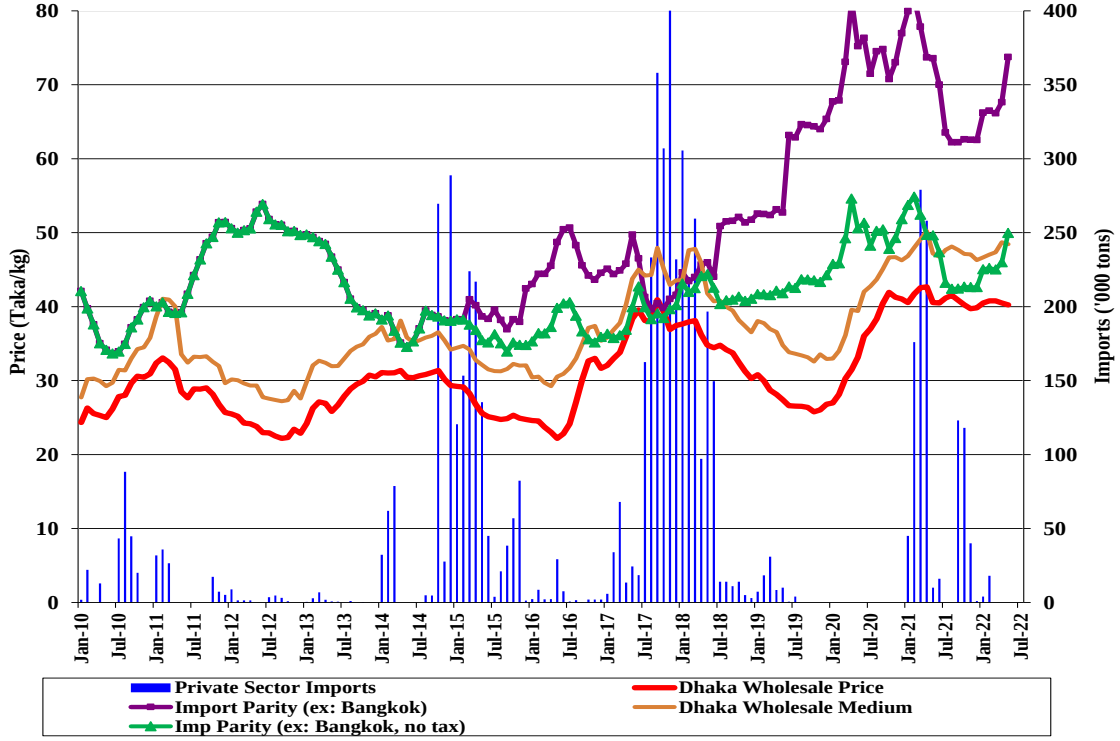
For most of the period from 2010 to 2014, domestic prices in Bangladesh were substantially below import parity prices and so the volume of rice imports was very small, (consisting mainly of aromatic

rice), (Figure 24). However, in 2017 and early 2018, domestic wholesale prices rose to import parity levels, making private sector imports of ordinary rice profitable. Import tariffs were low, so import parity prices with and without tariffs were almost the same.

In mid-2018, domestic wholesale prices fell due to a good harvest; import tariffs were also increased substantially, resulting in a wide gap between domestic prices and import parity.

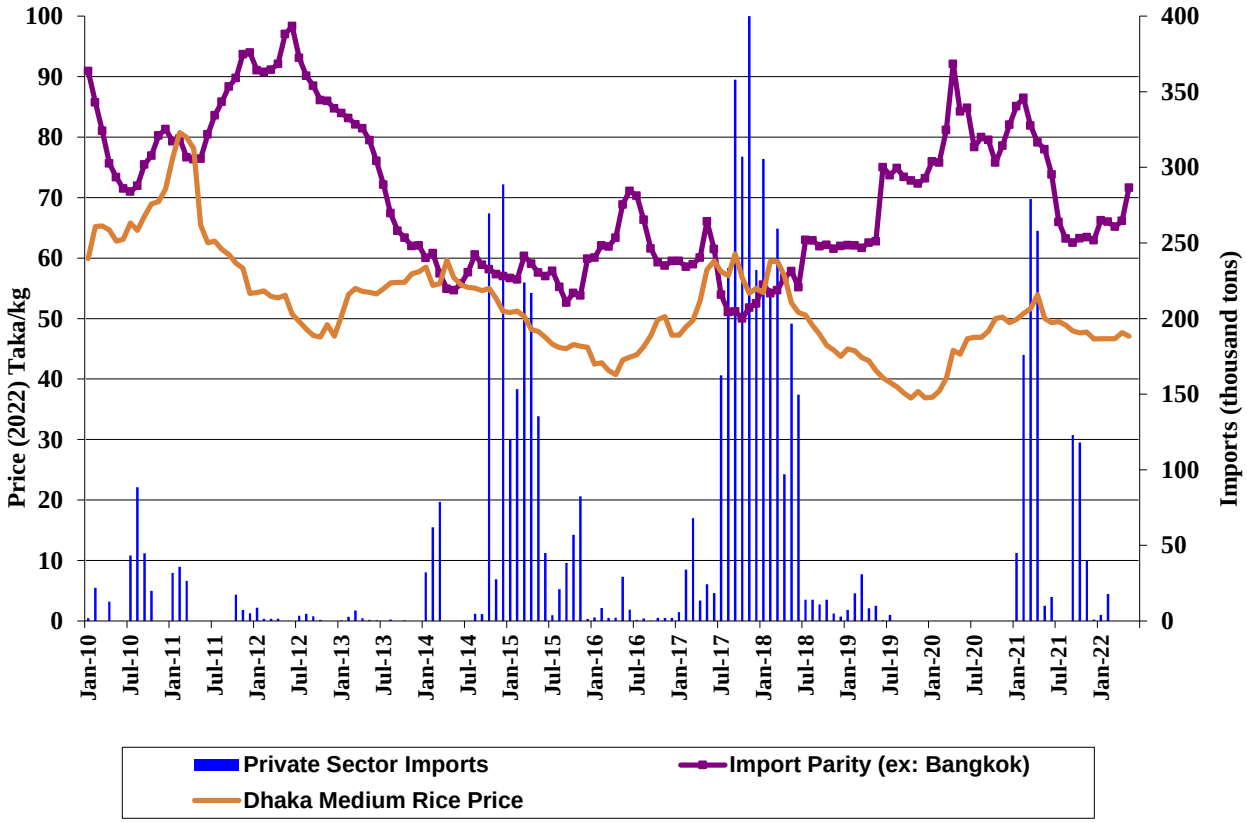
Domestic prices rose in early 2021. Although wholesale prices of coarse rice did not reach import parity levels, prices of medium-quality rice (which were generally about 8 Tk/kg higher), did reach import parity with rice in the wholesale market in India, again spurring rice imports for several months. Thus, it appears that because the quality of rice in the Bangladesh wholesale market has improved over time, the gap between the Bangladesh medium quality rice price and import parity using the Indian wholesale price has become the appropriate indicator of incentives for rice imports from India.

Figure 24. Private sector imports and parity prices of rice in Bangladesh, 2010-2022



Domestic prices of medium quality rice rose to import parity (without tax) levels in early in 2021 and in mid-2022. This private sector trade was profitable only because import tariffs for traders with successful tenders were lowered.

Figure 25. Import parity prices (2022 Tk/kg) and rice imports, 2010-2022



Adjusting for inflation using the CPI as a deflator, Figure 25 shows that real wholesale prices of rice trended downwards between 2010 and 2022.

Consumers benefit from lower real rice prices, but lower real prices also contribute to lower real incomes for producers. Other factors also influence real rice incomes, however, including yields and input costs.

4.3 Short-run impact of a supply shock

The following is a simple model of the effects of a supply shock in a closed economy (i.e., with zero imports or exports).

For simplicity, we assume that production (domestic supply) is fixed at some exogenous level S0 adjusted for a weather or other production shock):

$$S_1 = S_0 \times (1 + shock) \qquad (1)$$

Demand is a function of prices and household incomes:

$$D_1 = D_0 \times \left(\frac{P_1}{P_0}\right)^{\beta_1} \times \left(\frac{Y_1}{Y_0}\right)^{\beta_2} \qquad (2)$$

Here, S_0 and S_1 are supply in the base period (period 0) and period 1; D_0 and D_1 are demand in periods 0 and 1; Y_0 and Y_1 are (exogenous) incomes in periods 0 and 1, and the parameters β_1 and β_2 are the own-price elasticity and income elasticities of demand (i.e., the percentage changes in quantity demanded given a 1 percent change in the price (β_1) or income (β_2)).

In equilibrium, supply equals demand:

$$S = D \Rightarrow S_0 = D_0 \; and \; S_1 = D_1 \qquad (3)$$

Thus, substituting equations (1) and (2) into equation (3),

$$S_0 \; * \; (1 + shock) = D_0 \times \left(\frac{P_1}{P_0}\right)^{\beta_1} \times \left(\frac{Y_1}{Y_0}\right)^{\beta_2} \qquad (4)$$

Dividing both sides by S_0 gives:

$$(1 + shock) \; = \; \left(\frac{P_1}{P_0}\right)^{\beta_1} \; \times \left(\frac{Y_1}{Y_0}\right)^{\beta_2} \qquad (5)$$

Which implies:

$$\Rightarrow \frac{P_1}{P_0} \; = \left[\frac{\left(\frac{Y_1}{Y_0}\right)^{\beta_2}}{(1+shock)}\right]^{\frac{1}{\beta_1}} \qquad (6)$$

Figure 26 illustrates the effects of a negative supply shock. (Note that the supply curves S_0 and S_1 are vertical because production is assumed to be fixed, so it does not change when the price changes.) The shock reduces production, shifting the supply curve to the left from S_0 to S_1. At the same time, lower production implies lower incomes (Y_1 is less than Y_0), shifting the demand curve to the left from D_0 to D_1. Prices rise from P_0 to P_1.

If imports are endogenous, prices increase only up to the level of the import parity price, P_m, and imports fill the gap between demand (Q_2) and domestic supply (S_1).

Figure 26. Effects of supply shock in closed and open economies

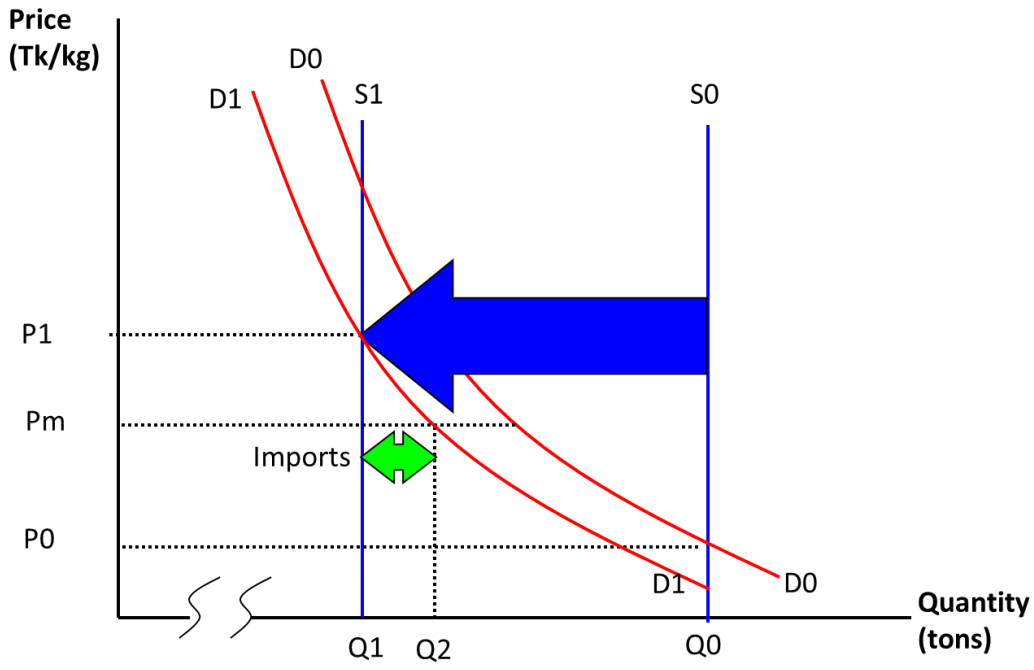


Table 1 presents a set of simulations of the short-run impacts of both a production and an income shock. We use the 2021/22 Aman harvest as a base. In the following season, a 3% increase in per capita incomes with no change in production or imports results in an increase in the real price of rice of about 2.6% to balance total supply with total demand.

In simulation 2, a 5% shortfall in the 2022/23 Aman harvest with no change in private imports, results in an income-adjusted supply fall of 5.3% and a sharp increase in the real price of rice of 16.8%. Simulation 3 presents the effects of the reverse scenario, such that production increases by 3%. As supply increases, prices fall by 4.8%.

Simulations 4 and 5 present alternative scenarios of production shocks coupled with liberalized private sector import regimes. In Simulation 4, the 5% production shortfall in the Aman harvest with liberalized private sector imports results in a flow of 392 thousand tons of rice imports to balance supply and demand. Compared to Simulation 2 (with no change in imports), total supply diminishes by only 3.3% (rather than 5.3%), and the real price increase is lower than it would have been without any increase in imports (10.1% in Simulation 4 vs. 16.8% in Simulation 2). In Simulation 5, we model an even larger production shortfall of 10%. In this scenario, the domestic price again rises to the import parity level (an increase of 10.1% relative to the base level). Private sector rice imports increase to 1.124 million tons.

Table 1: Simulations of the short-run impacts of supply and income shocks

	Nov-Apr 2021/22 Base Aman	Nov-Apr 2022/23 Sim 1 High Income	Nov-Apr 2022/23 Sim 2 Low Prod	Nov-Apr 2022/23 Sim 3 High Prod	Nov-Apr 2022/23 Sim 4 S2+Imports	Nov-Apr 2022/23 Sim 5 Very Low Prod + Imps
Production ('000 tons)	16.27	16.27	15.46	16.76	15.46	14.64
Aus ('000 tons)	0.00	0.00	0.00	0.00		
Aman ('000 tons)	16.27	16.27	15.46	16.76	15.46	14.64
Boro ('000 tons)						
Losses, seed, etc. (10 percent)	1.63	1.63	1.55	1.68	1.55	1.46
Net Production	14.64	14.64	13.91	15.08	13.91	13.18
Domestic Procurement	0.200	0.200	0.200	0.200	0.200	0.200
Public Distribution	2.000	2.000	2.000	2.000	2.000	2.000
Net Govt Injections	1.800	1.800	1.800	1.800	1.800	1.800
Private imports	0.063	0.063	0.063	0.063	0.392	1.124
Private stock change	0.000	0.000	0.000	0.000		
Supply	16.51	16.51	15.77	16.94	16.10	16.10
Supply less private stock change	16.51	16.51	15.77	16.94		
Demand	16.51	16.51	15.77	16.94	16.10	16.10
Per Capita Demand (kg/person/month)	16.66	16.66	15.92	17.11	16.26	16.26

	Nov-Apr 2021/22 Base Aman	Nov-Apr 2022/23 Sim 1 High Income	Nov-Apr 2022/23 Sim 2 Low Prod	Nov-Apr 2022/23 Sim 3 High Prod	Nov-Apr 2022/23 Sim 4 S2+Imports	Nov-Apr 2022/23 Sim 5 Very Low Prod + Imps
Per Capita Supply (% change)	0.0%	0.0%	-4.4%	2.7%	-2.4%	-2.4%
Per Capita Income (21/22 = 100)	1.00	1.03	1.03	1.03	1.03	1.03
Income Elasticity of Demand		0.30	0.30	0.30	0.30	0.30
Per Capita Demand Income Effect		0.9%	0.9%	0.9%	0.9%	0.9%
Own Price Elasticity of Demand		-0.35	-0.35	-0.35	-0.35	-0.35
Income Adjusted Shift in Supply		-0.9%	-5.3%	1.8%	-3.3%	-3.3%
Real Price Change (ed = -0.3; ey = 0.3)		2.6%	16.8%	-4.8%	10.1%	10.1%

Source: Author's calculations.

4.4 Priorities for further monitoring and analysis

The simulations illustrate the need for flexible and timely trade regimes to allow private sector imports in the event of major production shortfalls. Allowing these imports can be an effective policy in the event of sudden shocks to supply and relatively low import parity prices. Such a policy requires information on import parity prices (which serve as potential price ceilings following production shocks). Regular discussions with traders are also needed to provide crucial information on trade barriers and tariffs actually paid, changes in transport and other costs, and other problems and concerns related to the market.

In addition, timely dissemination of market information (in particular, the FPMU and DG Food databases on prices, production, imports and public stocks) can help inform decisions of various government ministries, as well as donors and private sector actors. FPMU's Food Situation Reports also provide important sources of information on domestic and international markets.

5 BANGLADESH AGRICULTURAL PRICE ANALYSIS AND PROJECTIONS TO JANUARY 2023

In this Chapter, we present analyses and projections from August 2022 to January 2023 for several key food commodities, namely rice, wheat, pulses (khesari and masur), edible oils (soybean and mustard), and onions. It is the hope of the IFPRI-led JV team that the public officials trained over the course of the workshop will be able to replicate these analyses at regular intervals in the future.

As covered in the training, the price projections we present herein are based on current prices, past price patterns in domestic and international markets, the current macro food inflation rate[4], and information on likely demand shocks. Prices of major import-dependent commodities such as edible oils experienced sharp increases starting in March 2022 because of the ongoing crisis in Ukraine and its resultant disruptions to global supply chains and trade. While rice prices in both domestic and international markets have remained largely stable, several other key commodities face uncertainties given a general rise in inflation, as well as increases in fuel and fertilizer prices.

We first present an analysis of rice and wheat prices, including incentives for private sector imports which have played a crucial role in price stabilization in Bangladesh in the past. We then present projections for rice and other commodities based on seasonality of prices and expected overall rates of inflation.

It is important to remember that **these projections are not predictions**. The effects of major unanticipated shocks, such as floods in April or May like those that damaged the Boro harvest in 2017, or damages to crops and infrastructure caused by cyclones or other disasters, are not included in this analysis. Moreover, localized, generally short-term (four to six months) price movements can occur that are not reflected in movements in average prices at the regional or national levels. Further refinements in the methodology and availability of new and more detailed information on markets and shocks can help improve the accuracy of these projections.

5.1 Cereal markets and prices (rice and wheat)

5.1.1 Rice markets

Even with the advent of the Ukraine crisis in late February 2022, rice prices have remained relatively stable in both Bangladesh and international markets. Wholesale coarse rice prices in Bangladesh only rose by 0.75% between January and March 2022, and then by a further 1.95% between March and July, thanks to good harvests in the 2021-22 Aman (rainfed) and 2022 Boro (irrigated) seasons.[5] World prices (FOB India, 25% broken[6]) rose by only 2.80% in US dollar terms between January and March 2022, and decreased slightly by 0.94% between March and July. Bangladesh prices in this period have similar patterns.

However, rice prices could yet experience upward ticks in the second half of the year, due to damage to the Aus crop from flash floods experienced in the Sylhet region in June—the USDA estimates a 25% reduction in Aus production for 2022 (USDA Grain and Feed Update, July 25, 2022).

[4] Note that, for July 2022, the monthly inflation as measured by the overall CPI (7.48%) was slightly lower than inflation in food prices (8.19%).

[5] United States Department of Agriculture (USDA) Grain and Feed Update, July 25, 2022.

[6] In recent years, Bangladesh has been sourcing nearly all its rice imports from India.

These floods, followed by a drought, have also resulted in only 25% of the area under Aman paddy to be planted so far this year (Department of Agricultural Extension (DAE), 2022).

Given continued uncertainty, it is important to have flexible tariff regimes, to be able to spur private sector imports in the event of domestic production shortfalls. Bangladesh maintained an extremely high tariff rate of 62.5% in the case of rice, which was only recently reduced to 25.75% in July (National Board of Revenue (NBR), 2022). Subsequently, the NBR further reduced the total tax incidence on rice imports to 15% on August 28, 2022 to promote private imports (NBR, 2022).

Since the early 1990s, when private sector rice imports were liberalized, import parity prices (equal to the calculated full cost of importing rice, including trade, transport, taxes and other costs) have served as a ceiling for domestic rice prices. Domestic prices have not risen above import parity in this period because importers have had sufficient access to foreign exchange to import rice and there has been significant competition in the import and wholesale rice trade markets in Bangladesh to severely limit any potential monopoly power of large traders.

The estimated import parity price of rice in July 2022, based on an FOB India price (25% broken) of $336.8/ton was BDT 44.22/kg (inclusive of a total tax incidence of 25.75%). The cost of imports is therefore 6.34% above the national average wholesale price of coarse rice (BDT 41.58/kg). Eliminating the import tariff altogether (or marginal increases in the domestic wholesale price and/or decreases in Indian FOB prices) would cause import parity prices to fall to BDT 40.17/kg, making private sector rice imports profitable.

5.1.2 Wheat markets

By contrast, wheat markets have been sharply affected by the Ukraine crisis in both domestic and international markets. Wholesale prices of wheat (red) in Bangladesh remained relatively stable between January and March 2022, decreasing by 1.29%. Since then, however, prices rose by 23.24% between March and July 2022, following April-May increases of 9.52%.

Indian prices (Delhi wholesale)[7], on the other hand, have remained low, decreasing by 6.59% between March and July 2022. This follows, however, an export ban from the country announced in May citing severe heat waves since March that affected production.[8] Between January and May 2022, Bangladesh sourced 75% of its monthly wheat imports from India on average. However, in June, imports from India fell sharply, with more than half being sourced from other markets (Figure 27). Given high wheat prices in the international market, the government of Bangladesh signed a deal to import around 500,000 tons of wheat from Russia wheat at $430/ton starting in January 2023 (Prothom Alo, Aug 28, 2022).

Unlike rice, the government of Bangladesh does not impose any tariffs on wheat imports, given the heavy dependence on imports to meet domestic demand. Import parity calculations therefore only need account for transport and shipping costs plus domestic marketing costs (transport from port of entry to Dhaka), where applicable. Import parity prices for Indian wheat rose by 1.86% between March and July, significantly less than the large percentage increase in domestic prices over the same period.

[7] Since late 2020, Bangladesh has shifted to sourcing a large portion of its grain imports from India, reducing its dependence on Russian and Ukrainian supplies.

[8] Indian wheat exports have continued to flow to Bangladesh against Letters of Credit (LCs) that had been opened before the ban had been announced.

5.2 Projections based on historical domestic price movements

Projected prices are calculated on the basis of trends in macro-economic inflation over the past 12 months, past seasonal price movements and a Ramadan adjustment factor equal to the average ratio of the price of rice in the month of Ramadan relative to an estimate of the rice price in non-Ramadan months (Equation 1).

$$PP(t) = P(t-1) \times \frac{sf(t)}{sf(t-1)} \times inf(t) \times RF(t) \qquad (1)$$

where,

- $PP(t)$ is the projected price in period t,
- $P(t-1)$ is the actual or projected price in period (t-1),
- $sf(t)$ is the seasonal factor for the month of period t, estimated from historical data,[9]
- $inf(t)$ is the monthly rate of inflation, calculated using data from the most recent CPI data for the July 2021-July 2022 period (8.2% annual inflation, equivalent to 0.7% per month), and
- $RF(t)$ is the Ramadan adjustment factor, calculated as the average price increase relative to seasonally adjusted trend (used only for Ramadan months, e.g. April 2022).[10]

The resulting projections for national average coarse and medium-quality rice are shown in Figure 28 and Table 2. With a good Boro harvest and an anticipated normal aman harvest in 2022, and assuming no disruptions to transport networks, the price of coarse rice is projected to remain stable, decreasing slightly from BDT 41.15/kg in July 2022 to BDT 40.48/kg in January 2023, a marginal decrease of 2.48% in nominal terms. The price of medium-quality rice over this period is also projected to fall by 3.03%.[11]

By contrast, projections of prices for other commodities indicate varying degrees of instability over the August 2022 through January 2023 period (Table 2 and Figure 29 to Figure 32). Percentage changes of commodities dependent on international trade such as wheat, pulses (masur) and soybean oil range from 7.3 to 16.6% in the August 2022 through January 2023 period, as supply chain issues continue to persist. Onion prices, on the other hand, are projected to fall by 16.6% over the same period, provided the previous price trend for the last several years holds. Further analysis of the conditions in international markets is needed to refine these projections, however.

5.3 Calculations of confidence intervals

Using the average actual price deviations in the August 2021 through January 2022 period, 90 percent confidence intervals have been generated for all commodities under consideration. These confidence intervals are based on historical price variations relative to projected mean values. We use the following formula to generate confidence intervals:

$$CI = PP_{m,Y} \pm Z * stdev$$

[9] The seasonal price factors are estimated from Department of Agricultural Marketing (DAM) monthly data from 2003 to 2021, as the average percent deviation of the wholesale price relative to a 6-month centered moving average.

[10] Ramadan prices of coarse rice were an estimated 0.8% higher than the seasonally adjusted moving average in the 2003 to 2021 period.

[11] Note that projections of rice prices for August 2021 to January 2022 using data up to July 2021 (also shown in Figure 3) were quite close to actual prices.

$$where\ stdev = \sqrt{\frac{\sum_m (P_{m,Y-1} - PP_{m,Y-1})^2}{N}}$$

where,

- $PP_{m,Y}$ is the projected price in month m for the year Y,
- $P_{m,Y-1}$ is the actual price in month m for the year Y-1,
- Y is the year,
- m is the month index,
- Z is the confidence level factor (equal to 1.645 for a 90 percent confidence interval, assuming a normal distribution), and
- N is the number of projected months in year Y-1

Confidence intervals for national average coarse and medium rice prices are reported in Table 3, and the corresponding graphs are presented in the Figure 28. Table 3 shows that the projected average price of coarse rice over the August 2022 to January 2023 period of BDT 43.02/kg is bounded within BDT 39.78 (lower limit) and BDT 46.27/kg (upper limit). Similarly, the 90% confidence interval for the projected average price of medium rice of BDT 51.88/kg has a lower limit of BDT 49.04 and an upper limit of BDT 54.71/kg.

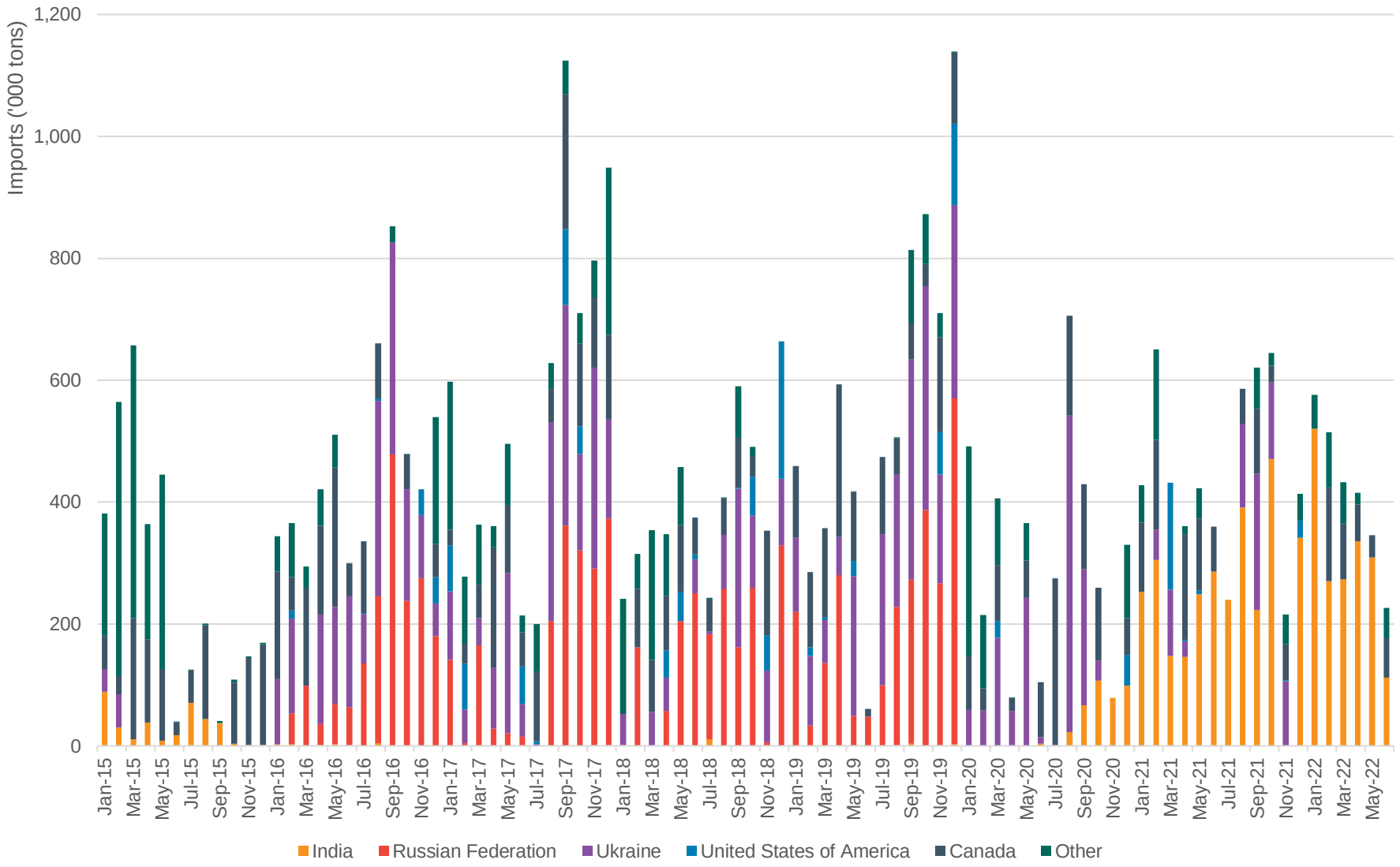
The price bands for other commodities except pulses (masur) and edible oils (soybean and mustard) are generally small, though wider than the price bands for rice. Given the sudden deviations in masur prices over the same months in the previous year, as well as the recent surges in soybean oil prices, the confidence intervals for projected masur and soybean oil prices are likewise large.

5.4 Summary

The projections presented here are designed to provide approximations of likely future price movements, assuming that harvests are near normal levels and that the usual seasonal price patterns hold. Based on these assumptions, nominal domestic prices of rice are expected to be stable, especially since domestic prices are now near import parity levels. Thus, a relatively small reduction in domestic production or a fall in the world price in Taka terms would make private sector imports of medium quality rice profitable. Wheat prices, which in the last several years have been largely determined by the cost of imported wheat from India, are likely to remain high, though imports from Russia may prevent a future spike in prices. Prices of other commodities are, in general, expected to rise only gradually in the coming months. The exception, however, is onions for which there is considerable uncertainty regarding movements for both imported and local products.

Finally, it is important to note that these projections, which rely mainly on structural patterns (seasonal price movements and expectations of overall inflation) should be updated as new data become available and market or policy conditions change.

Figure 27: Bangladesh: Monthly wheat imports by source, January 2015-June 2022



Source: UN Comtrade database, updated to June 2022.

Table 2: Actual and projected prices (BDT/kg) of major food commodities, July-January 2021-22 and 2022-23

	Jul 2021	Aug 2021	Jan 2022	Aug 2021-Jan 2022 Nominal % change	Aug 2021-Jan 2022 Real % change	Jul 2022	Proj. Aug 2022	Proj. Jan 2023	Proj. Aug 2022-Jan 2023 Nominal % change	Proj. Aug 2022-Jan 2023 Real % change
Coarse Rice	41.2	41.5	40.5	-2.48%	-5.55%	41.6	42.4	43.7	3.13%	-0.11%
Medium Rice	47.7	48.1	46.7	-3.03%	-6.08%	50.5	50.8	52.6	3.62%	0.37%
Wheat (Red)	26.2	26.2	29.0	10.76%	7.28%	36.0	36.4	37.9	4.29%	1.02%
Wheat (White)	26.3	26.1	29.3	12.42%	8.89%	35.3	35.8	37.4	4.52%	1.24%
Pulses (Khesari)	52.0	47.1	47.2	0.30%	-2.84%	50.5	50.2	53.0	5.40%	2.09%
Pulses (Masur)	60.3	60.0	71.9	19.79%	16.03%	79.1	79.9	82.1	2.72%	-0.50%
Onions (Local)	36.0	38.5	33.2	-13.86%	-16.56%	36.9	37.8	30.8	-18.59%	-21.15%
Onions (Imported)	34.2	34.6	35.2	1.73%	-1.46%	35.1	36.2	33.2	-8.33%	-11.21%
Soybean Oil	107.3	119.2	143.5	20.34%	16.56%	192.3	196.1	206.9	5.49%	2.18%
Mustard Oil	148.1	152.7	167.0	9.37%	5.94%	214.1	214.6	222.6	3.72%	0.46%

Source: Department of Agricultural Marketing (DAM) data and authors' calculations.

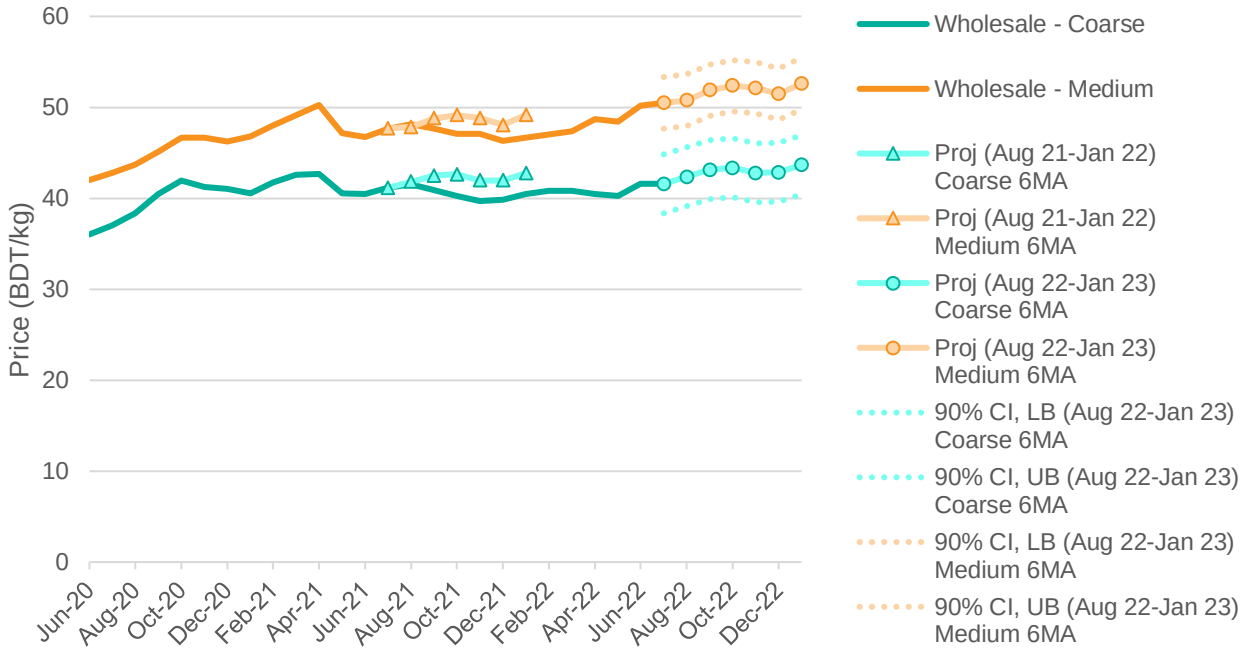
Table 3: Average projected prices and confidence intervals, August 2022-January 2023

	Average projected price (Aug 22 – Jan 23)	Lower bound (90% CI)	Upper bound (90% CI)	MSE (Aug 21 – Jan 22)
Coarse Rice	43.0	39.8	46.3	3.9
Medium Rice	51.9	49.0	54.7	3.0
Wheat (Red)	37.2	35.0	39.4	1.8
Wheat (White)	36.6	34.3	38.9	2.0
Pulses (Khesari)	51.5	42.6	60.3	29.0
Pulses (Masur)	81.2	55.1	107.3	251.6
Onions (Local)	37.9	25.7	50.2	55.6
Onions (Imported)	37.3	28.2	46.4	30.7
Soybean Oil	200.0	162.8	237.2	511.2
Mustard Oil	218.1	200.7	235.5	111.8

Source: DAM data and authors' calculations.

Note: 90% CI = 90% confidence interval; MSE = Mean squared error.

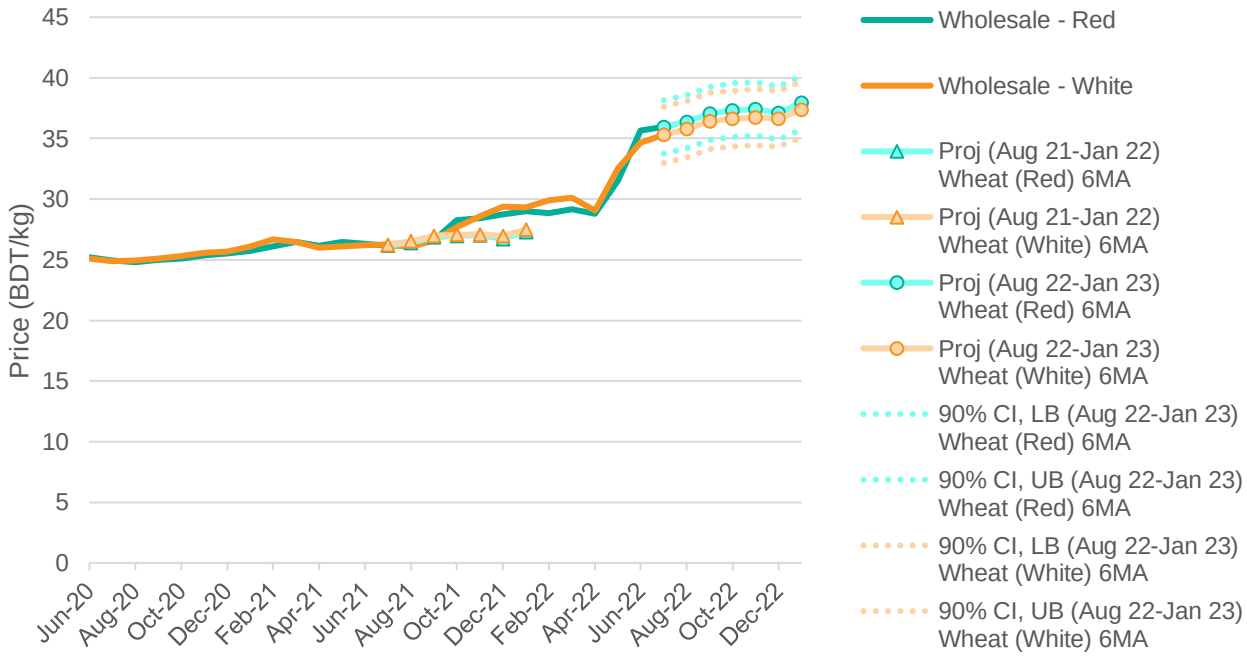
Figure 28: Bangladesh: Actual and projected prices of coarse and medium-quality rice, Jun 2020-Jan 2023



Source: DAM data and authors' calculations.

Note: (1) Projected – Coarse Rice (Aug 22-Jan 23) = Price projections based on current trend. Seasonality calculated with Jan 2003-Jul 2022 data; actual prices used through Jul 2022. (2) 6MA = six-month moving average of prices. (3) 90% CI = 90% confidence interval; LB = lower bound, UB = upper bound.

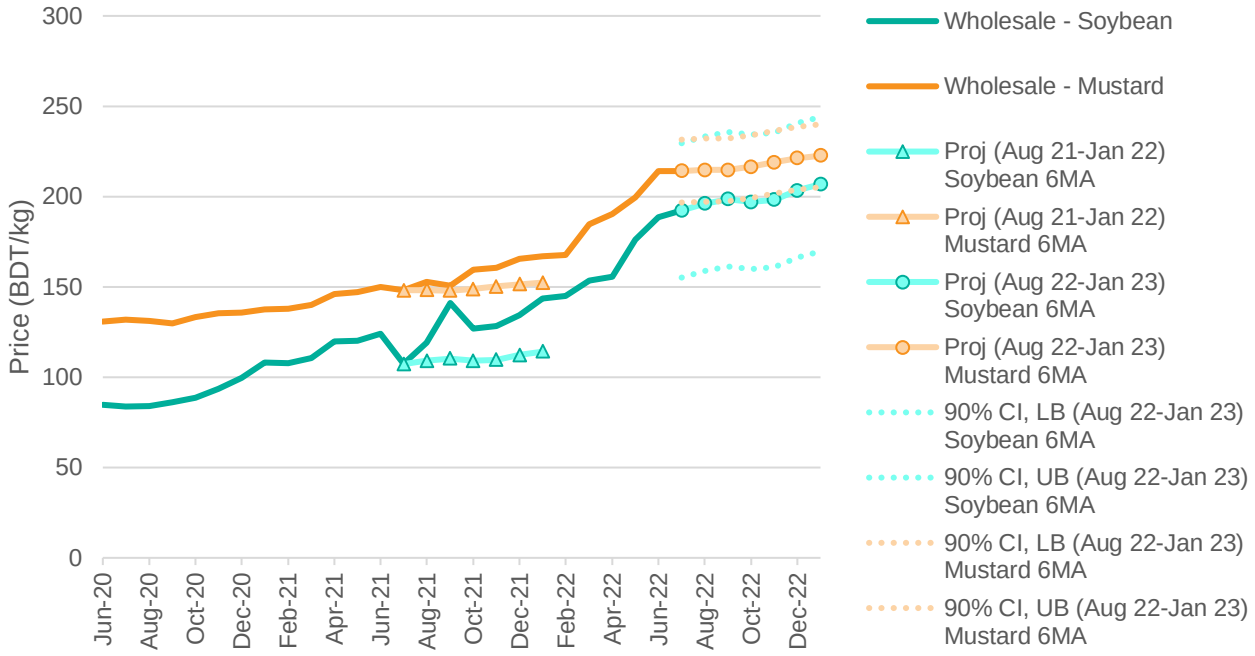
Figure 29: Bangladesh: Actual and projected prices of wheat, Jun 2020-Jan 2023



Source: DAM data and authors' calculations.

Note: (1) Projected – Red Wheat (Aug 22-Jan 23) = Price projections based on current trend. Seasonality calculated with Jan 2003-Jul 2022 data; actual prices used through July 2022. (2) 6MA = six-month moving average of prices. (3) 90% CI = 90% confidence interval; LB = lower bound, UB = upper bound.

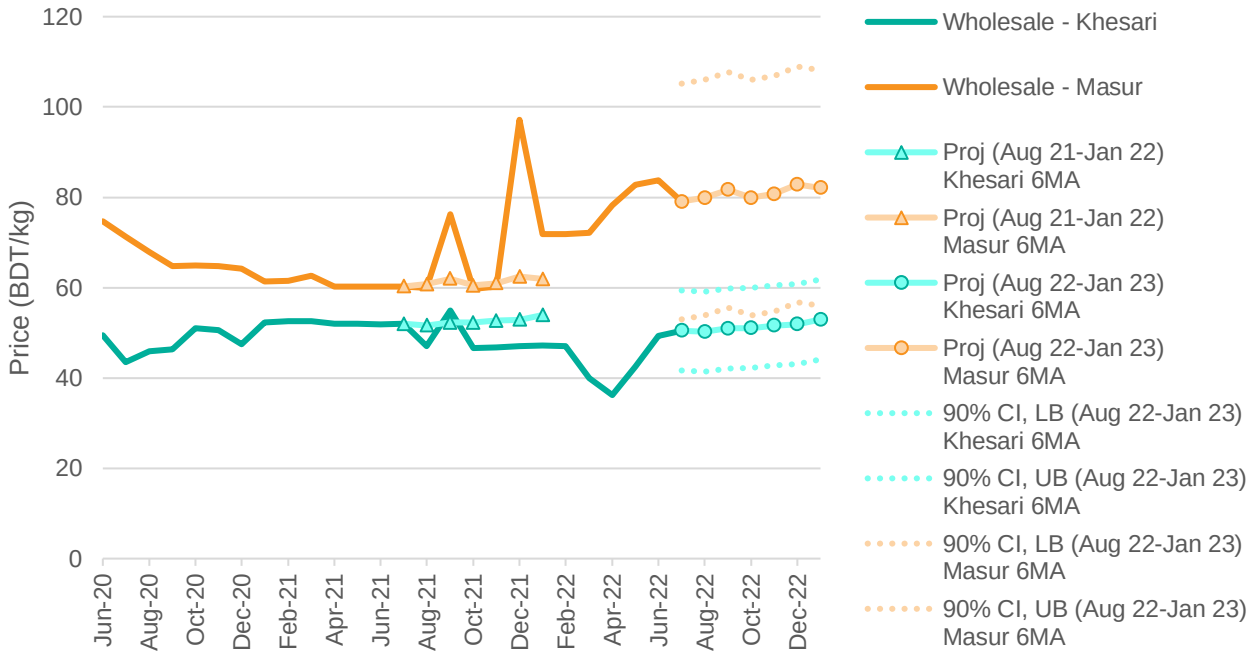
Figure 30: Bangladesh: Actual and projected prices of edible oils, Jun 2020-Jan 2023



Source: DAM data and authors' calculations.

Note: (1) Projected – Soybean Oil (Aug 22-Jan 23) = Price projections based on current trend. Seasonality calculated with Jan 2003-Jul 2022 data; actual prices used through Jul 2022. (2) 6MA = six-month moving average of prices. (3) 90% CI = 90% confidence interval; LB = lower bound, UB = upper bound.

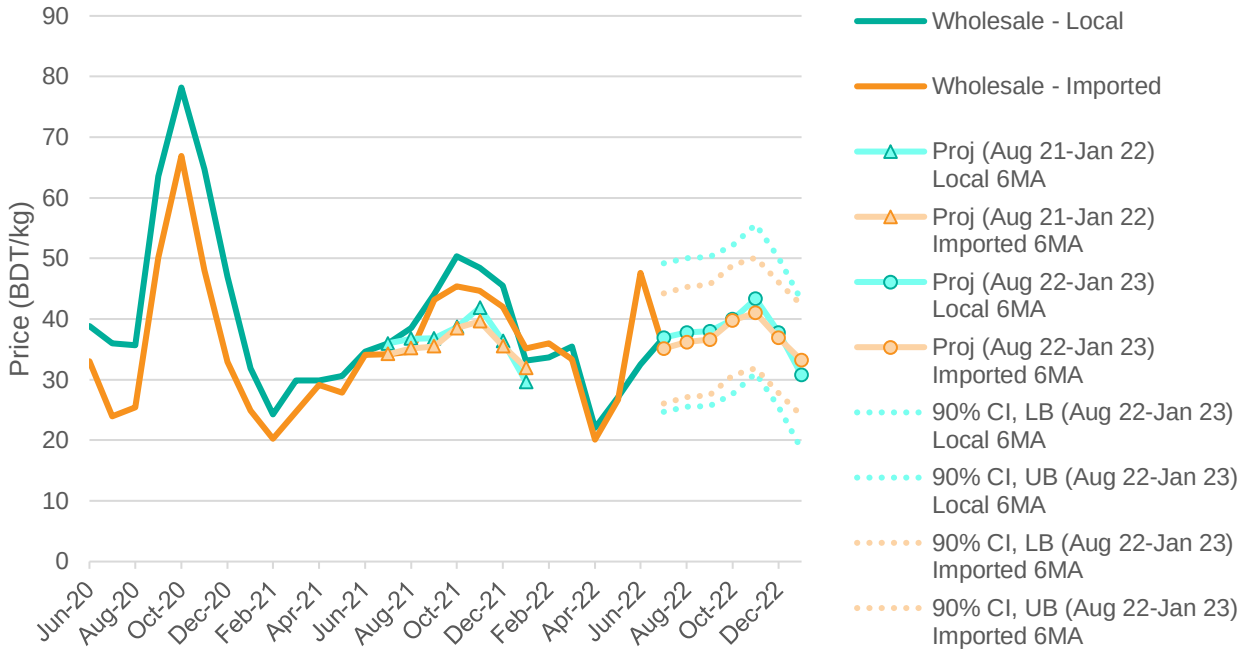
Figure 31: Bangladesh: Actual and projected prices of pulses, Jun 2020-Jan 2023



Source: DAM data and authors' calculations.

Note: (1) Projected – Masur (Aug 22-Jan 23) = Price projections based on current trend. Seasonality calculated with Jan 2003-Jul 2022 data; actual prices used through Jul 2022. (2) 6MA = six-month moving average of prices. (3) 90% CI = 90% confidence interval; LB = lower bound, UB = upper bound.

Figure 32: Bangladesh: Actual and projected prices of onions, Jun 2020-Jan 2023



Source: DAM data and authors' calculations.

Note: (1) Projected – Local onion (Aug 22-Jan 23) = Price projections based on current trend. Seasonality calculated with Jan 2003-Jul 2022 data; actual prices used through Jul 2022. (2) 6MA = six-month moving average of prices. (3) 90% CI = 90% confidence interval; LB = lower bound, UB = upper bound.

Supplementary Table 1: Bangladesh: Wholesale and import parity prices of rice, 2022

	Wholesale Coarse (BDT/kg)	Wholesale Medium (BDT/kg)	FOB India 25% broken ($/ton)	Import Parity 25% broken (BDT/kg)
January 2022	40.5	46.7	330.8	51.6
March 2022	40.8	47.4	340.0	53.0
April 2022	40.5	48.7	326.0	51.2
May 2022	40.2	48.4	329.3	53.1
July 2022	41.6	50.5	336.8	44.2
January-March	0.75%	1.50%	2.80%	2.74%
March-April	-0.73%	2.86%	-4.12%	-3.43%
April-May	-0.65%	-0.55%	1.00%	3.81%
March-May	-1.37%	2.29%	-3.16%	0.25%
March-July	1.95%	6.64%	-0.94%	-16.51%

Source: DAM and FAO rice price update data, and authors' calculations.

Note: The import tariff rate (total tax incidence, inclusive of customs and regulatory duties, VAT and AIT) as per the National Board of Revenue (NBR) stood at 62.5% between January and June 2022, and was revised to 25.75% in July. Import parity prices calculated assuming shipping costs of $31/ton, and domestic marketing costs (land port-Dhaka) of BDT 1/kg, as per the most recent Daily Food Situation Report (August 28, 2022) of the Food Planning and Monitoring Unit (FPMU).

ANNEX 1. TRAINING SCHEDULE

INTEGRATED FOOD POLICY RESEARCH PROGRAM (IFPRP)

Training on
Market Price Analysis and Projections

Date:
July 20-21, 2022

Venue:
Food Planning and Monitoring Unit (FPMU) Conference Room

Resource Person:

Dr. Paul Dorosh
Director, Development Strategy and Governance Division
International Food Policy Research Institute (IFPRI)

Tentative Program

	July 20, 2022	July 21, 2022
Inauguration Session	**9:30 – 9:50 AM**	-
Opening Remarks from Mr. Md. Shahiduzzaman Faruki, Director General, FPMU	9:30 – 9:40 AM	-
Remarks from Paul Dorosh, Ph.D., Director, Development Strategy and Governance Division (DSGD), IFPRI	9:40 – 9:50 AM	-
Tea break	9:50 – 10:00 AM	-
Session 1		
Training	10:00 – 11:15 AM	10:00 – 11:15 AM
Tea break	11:15 – 11:30 AM	11:15 – 11:30 AM
Training (continued)	11:30 AM – 1:00 PM	11:30 AM – 1:00 PM
Lunch	1:00 – 2:00 PM	1:00 – 2:00 PM
Session 2		
Training	2:00 – 3:00 PM	2:00 – 3:00 PM
Tea break	3:00 – 3:15 PM	3:00 – 3:15 PM
Training (continued)	3:15 – 4:30 PM	3:15 – 4:30 PM

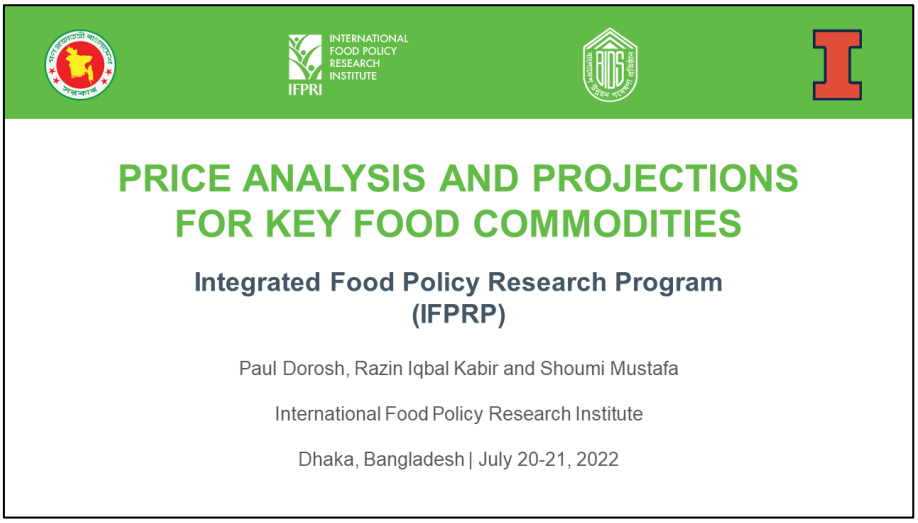
	July 20, 2022	July 21, 2022
Certificate Awarding Ceremony	-	**4:30 – 5:35 PM**
Remarks from the Project Director, MFSP Mr. Md. Rezaul Karim Sheikh	-	4:30 – 4:40 PM
Remarks from the Special Guest Mr. Abdullah Al Mamun, Additional Director General, DG Food	-	4:40 – 4:50 PM
Remarks from the Guest of Honor Mr. Md Shakhawat Hossain, Director General, DG Food	-	4:50 – 5:00 PM
Remarks from the Chair Mr. Md. Shahiduzzaman Faruki, Director General, FPMU	-	5:00 – 5:10 PM
Remarks from the Chief Guest Mr. Md. Ismiel Hossain NDC, Secretary, Ministry of Food	-	5:10 – 5:20 PM
Certificate Awarding by the Chief Guest **Mr. Md. Ismiel Hossian NDC,** **Secretary, Ministry of Food**	**-**	**5:20 – 5:30 PM**
Vote of thanks Shoumi Mustafa, Ph.D. Senior Research Coordinator, IFPRI	-	5:30 – 5:35 PM
Tea and snacks		

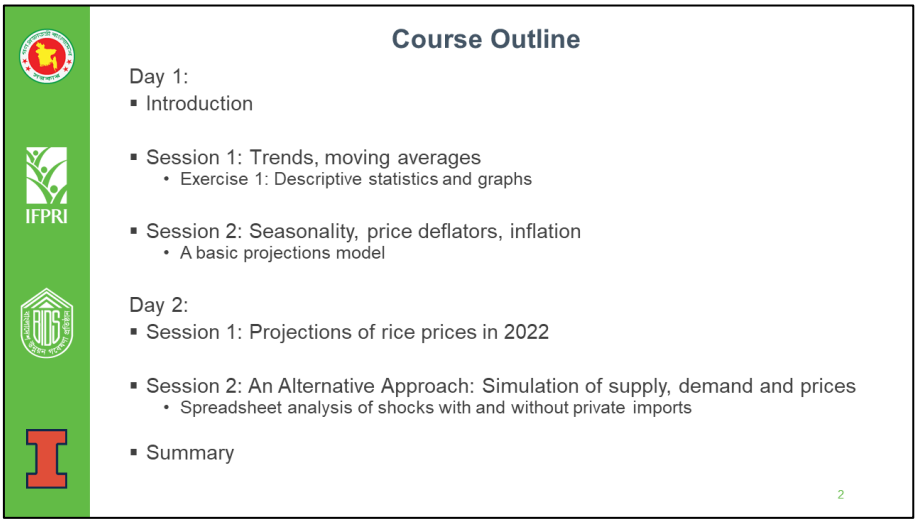
ANNEX 2. LIST OF TRAINEES

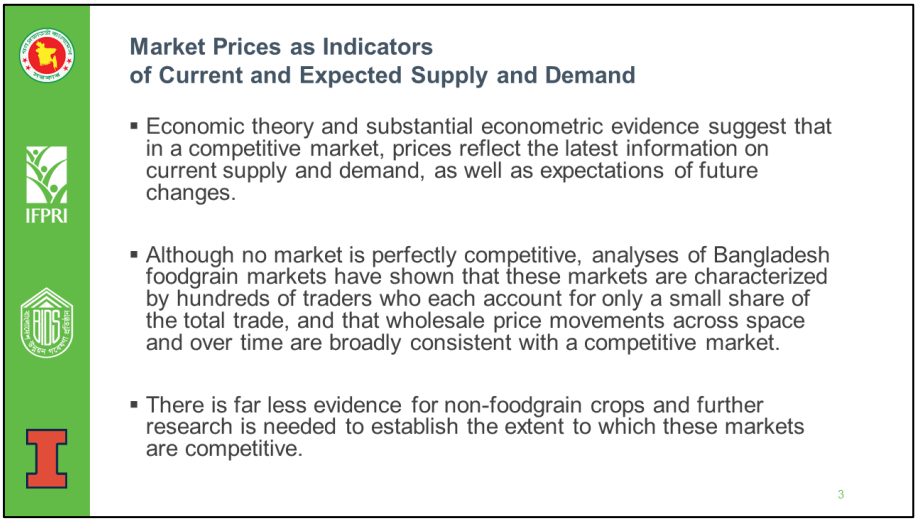
Sl. No.	Name	Designation	Organization
1	Feroz Al Mahmud	Research Director	Food Planning and Monitoring Unit (FPMU), Ministry of Food
2	Sharmin Yasmin	Senior Assistant Secretary	Ministry of Food
3	Mezanur Rahman	Associate Research Director	FPMU, Ministry of Food
4	Md. Mehedi Hasan Sohag	Research Officer	FPMU, Ministry of Food
5	Hillul Bhowmik	Research Officer	FPMU, Ministry of Food
6	Saleh Akram Akanda	Research Officer	FPMU, Ministry of Food
7	Md. Masud Rana	Research Officer	FPMU, Ministry of Food
8	Sayful Kabir Khan	Deputy Director, Procurement Division	Directorate General of Food (DG Food)
9	Afif-Al-Mahmud	Deputy Director (in charge), Supply, Distribution and Marketing Division	DG Food
10	Md. Fazle Rabbi Haider	Deputy Director (in charge), Movement, Storage and Silo Division	DG Food
11	M. A. Ahad Khandoker	Assistant Controller of Food, MIS & M Department	DG Food
12	Saleh Aziz	Assistant Controller of Food, Procurement Division	DG Food

ANNEX 3. PRESENTATION SLIDES

5.5 Presentation 1: Introduction to the Course





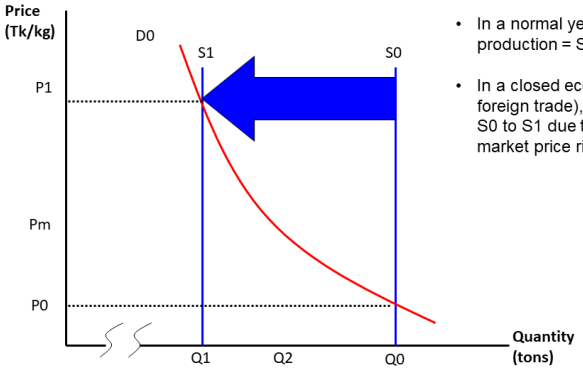


Forecasting Short-Term Future Prices: Applications to Bangladesh Agricultural Product Markets

- Given that market prices reflect current supply and demand, as well as expectations of future changes, we use a price forecasting model based on current prices and past price patterns, including recent price trends, seasonal movements in prices and price spikes in Ramadan.
- The effects of **unexpected changes** in government policy (e.g. procurement, distribution, tariffs) or weather are not captured in this (or any other) forecasting approach.
- This short-term price forecasting approach is able to closely replicate price movements in early 2019 (January-May/June) for rice, wheat and several other major commodities.
  - A structural model of supply and demand is more appropriate for longer-term forecasts or for simulating the effects of policy changes or supply and demand shocks.

4

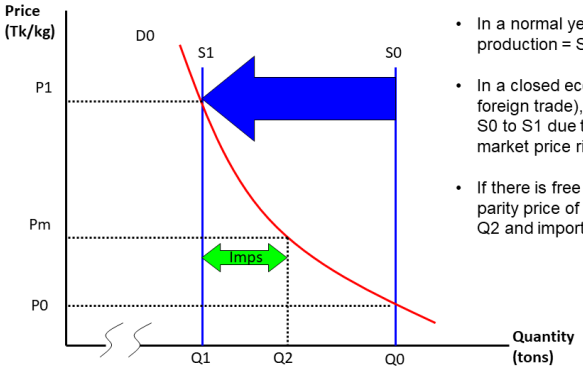
Short-run Impact of a Supply Shock



- In a normal year, domestic production = S0 and price = P0
- In a closed economy (i.e. with no foreign trade), if supply declines from S0 to S1 due to a weather shock, the market price rises to P1.

5

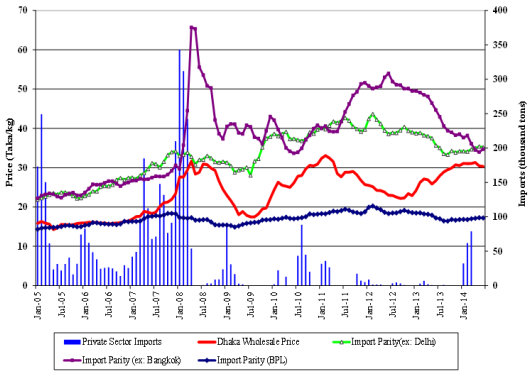
Short-run Impact of a Supply Shock



- In a normal year, domestic production = S0 and price = P0
- In a closed economy (i.e. with no foreign trade), if supply declines from S0 to S1 due to a weather shock, the market price rises to P1.
- If there is free trade with an import parity price of Pm, then total supply is Q2 and imports = (Q2-Q1)

6

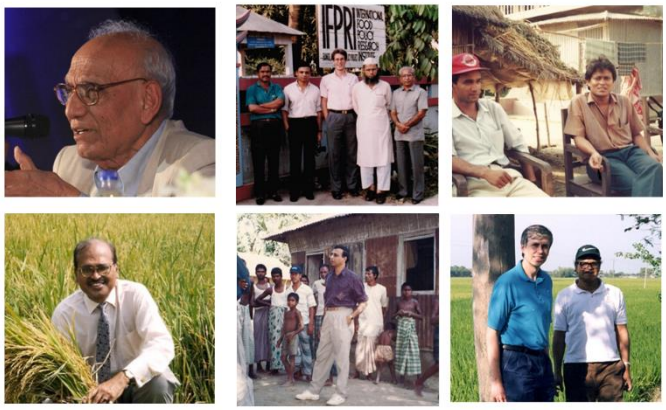
Price Stabilization through Subsidized Trade: 2002/03 to 2006/07



- In 2000/01 and again from 2002/03 to 2006/07, Bangladesh prices tracked import parity based on BPL sales prices.
- A specific Indian government program existed in 2002/3 for subsidized exports of rice obtained from FCI stocks at BPL prices.
- There were no explicit policy statements regarding export subsidies in later years. Econometric analysis shows that there was a statistically significant co-movement of wholesale and import parity prices in this period.

7

IFPRI in Bangladesh



8

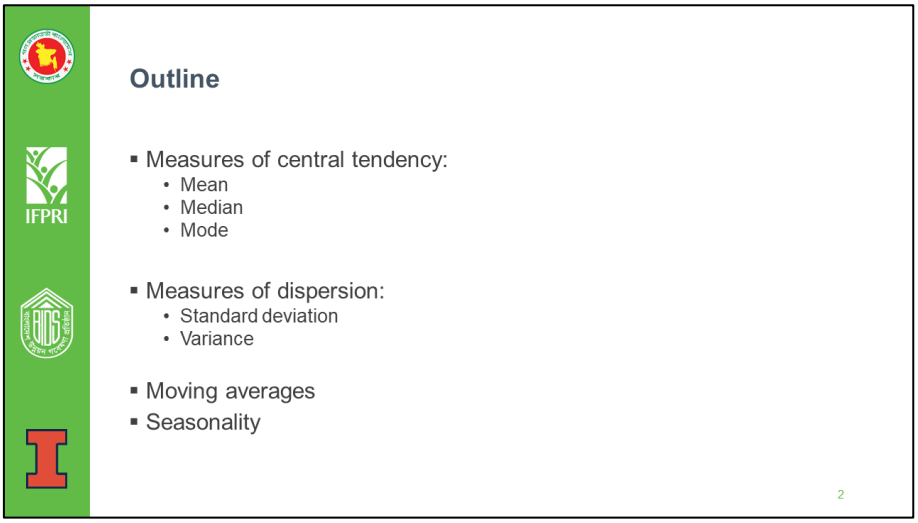
5.6 Presentation 2: Descriptive Statistics and Trends

DESCRIPTIVE STATISTICS AND TRENDS

Training on Market Price Analysis and Projections

Razin Iqbal Kabir
Integrated Food Policy Research Program
International Food Policy Research Institute

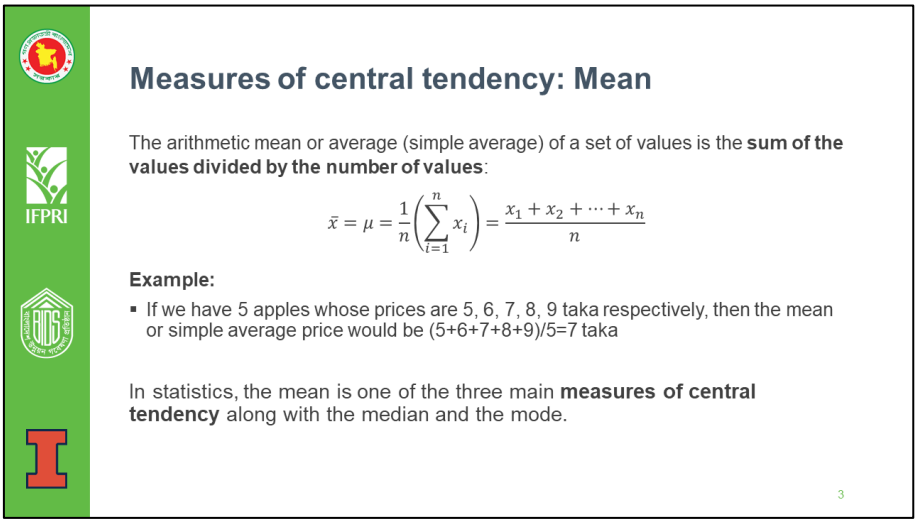
Dhaka, Bangladesh | July 20-21, 2022



Outline

- Measures of central tendency:
  - Mean
  - Median
  - Mode
- Measures of dispersion:
  - Standard deviation
  - Variance
- Moving averages
- Seasonality

2



Measures of central tendency: Mean

The arithmetic mean or average (simple average) of a set of values is the **sum of the values divided by the number of values**:

$$\bar{x} = \mu = \frac{1}{n}\left(\sum_{i=1}^{n} x_i\right) = \frac{x_1 + x_2 + \cdots + x_n}{n}$$

Example:

- If we have 5 apples whose prices are 5, 6, 7, 8, 9 taka respectively, then the mean or simple average price would be (5+6+7+8+9)/5=7 taka

In statistics, the mean is one of the three main **measures of central tendency** along with the median and the mode.

3

Measures of central tendency: Median

The median of a set of values is **the "middle value"** when the values are sorted from smallest to largest. This effectively means that 50% of the observations are below this number, and 50% are above it. In an **odd** number of ordered observations, the median is calculated as follows:

$$median(x) = x_{(n+1)/2}$$

For example, in a set of 7 numbers ordered 1, 3, 4, 6, 9, 9, 10, the median is the (n+1)/2th term = (7+1)/2 = 4th term, i.e., 6.

In an **even** number of observations, the median is effectively the average of the two 'middle' terms:

$$median(x) = \frac{x_{(n/2)} + x_{(n/2)+1}}{2}$$

For example, in set of 6 numbers ordered 1, 2, 5, 7, 8, 8, the median is the (n/2)th term (3rd term) plus the (n/2)+1th term (4th term) divided by 2, i.e., (5+7)/2 = 6.

In our previous example of prices of apples, what would be the median price?

4

Measures of central tendency: Mode

The mode is the **value that appears most often** in a set of data values

Like the statistical mean and median, the mode is a way of expressing, in a (usually) single number, important information about a random variable or a population. The numerical value of the mode is the same as that of the mean and median in a normal distribution, and it may be very different in highly skewed distributions.

- For example, the mode of the sample [1, 3, 6, 6, 6, 6, 7, 7, 12, 12, 17] is 6.
- Given the list of data [1, 1, 2, 4, 4], its mode is not unique.

5

Measures of central tendency: Excel exercise

- We will now perform calculations of these measures in Excel.
- Please refer to the Excel file **"Descriptive statistics_Training.xlsx"**.

6

Measures of dispersion: Standard deviation

The standard deviation (SD) is a measure of the variation in a set of values. A low standard deviation indicates that the values tend to be close to the mean, and a high standard deviation indicates that they are spread out over a wider range. In the simplest terms, the standard deviation (σ) of a sample of values is as follows:

$$\sigma = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2}$$

where $\{x_1, x_2, \cdots, x_N\}$ are the observed values, and $\bar{x}$ **is the mean** of these observed values. N **is the size of the sample**, and $N-1$ **is the number of degrees of freedom**.

- SD is one of the **measures of dispersion** in statistics.

7

Measures of dispersion: Variance

The variance (σ^2) is the expectation of the squared deviation of a random variable from its population mean or sample mean.

$$\sigma^2 = \frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2$$

where $\{x_1, x_2, \cdots, x_N\}$ are the observed values, and $\bar{x}$ **is the mean** of these observed values. N **is the size of the sample**, and $N-1$ **is the number of degrees of freedom**.

- Like the standard deviation, the variance is another important measure of dispersion in statistics.
- Note that the standard deviation is in effect the square root of the variance.

8

Measures of dispersion: Excel exercise

- We will now perform calculations of the standard deviation and variance in Excel.
- Please refer to the Excel file **"Descriptive statistics_Training.xlsx"**.

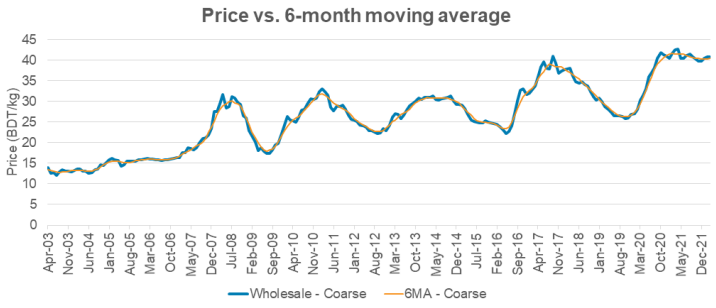
9

Moving average

- A simple moving average (or rolling/running average) is the unweighted mean of a number of data points in a series. For a given period, say a month, this can be the average of prior months, or incorporate future months.
- For example, a 6-month simple moving average of April 2003 prices would be the average of January 2003 to June 2003 prices.
- A moving average is commonly used with time series data to smooth out short-term fluctuations and highlight longer-term trends or cycles.

10

Price vs. moving average



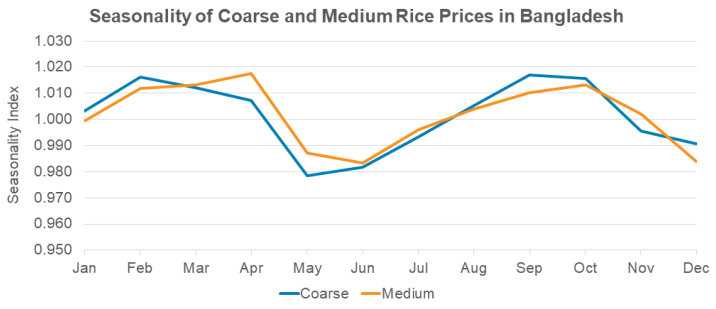
11

Seasonality

- Seasonality is the presence of periodic fluctuations that occur at regular intervals. In a year, there could be seasonality in prices of certain commodities.
- Seasonality in the case of agricultural commodity prices is related to harvest periods. Typically, prices are lowest at harvest time, and increase slowly until the next harvest due to storage costs.

12

Seasonality (cont'd.)



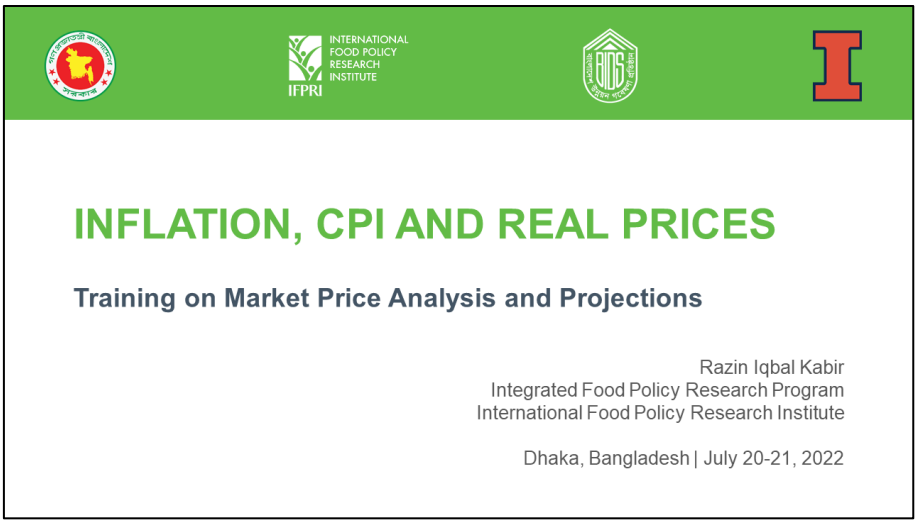
13

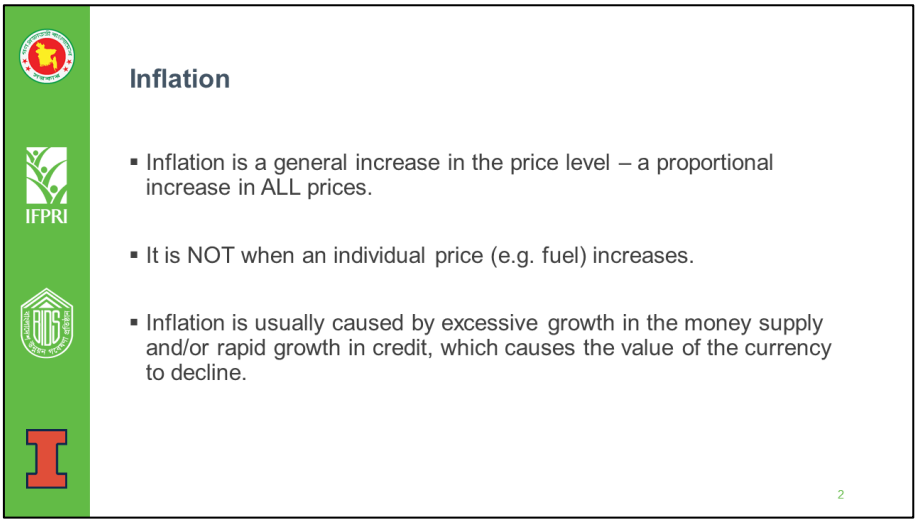
Excel exercises

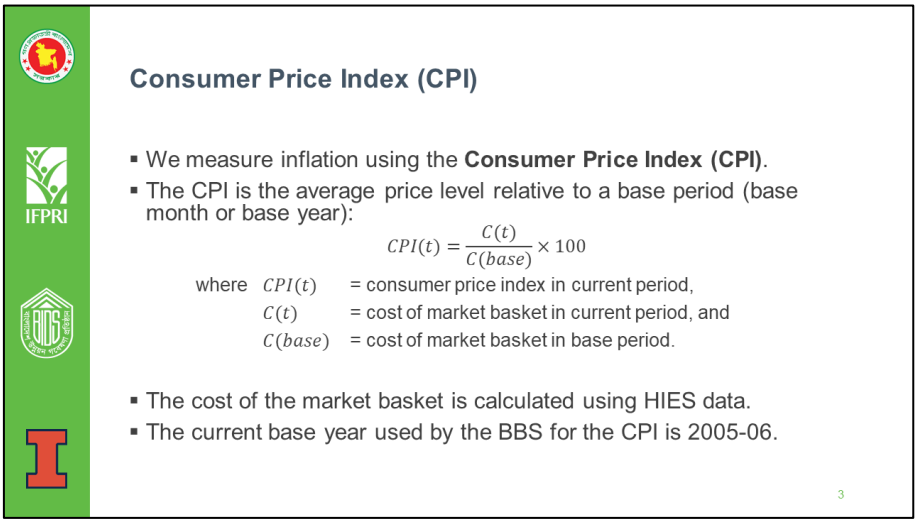
- We will now perform calculations of moving averages and seasonality in Excel.
- Please refer to the Excel file **"Moving averages_Training.xlsx"**.

14

5.7 Presentation 3: Inflation, CPI and Real Prices







Measuring inflation using the CPI

- Inflation is measured using the percentage difference in the CPI between two periods.
- For example, in Bangladesh:
  May 2022 ➔ Food CPI (base: 2005-06) = 334.02
  May 2021 ➔ Food CPI (base: 2005-06) = 308.41

  The point-to-point food inflation between the two periods is:

$$\left(\frac{CPI(May\ 2022)}{CPI(May\ 2021)}\right) - 1 \times 100 = \frac{334.02}{308.41} - 1 \times 100 = 8.30\%$$

4

Using CPI to calculate real prices

- What we observe in the market is the **nominal price** (e.g., the wholesale and retail prices for commodities), which reflects current monetary values.
- **Real prices** are prices adjusted for inflation:

$$Real\ price = \frac{Nominal\ price}{CPI\ in\ same\ month/100}$$

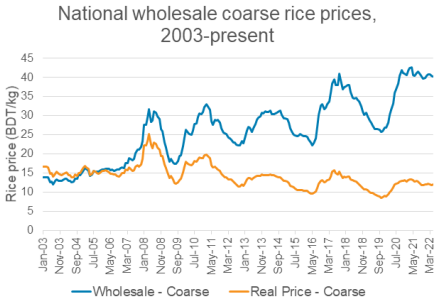
- For example, the wholesale price of coarse rice in January 2022 was BDT 40.48/kg. The real price (base = 2005-06) is:

$$= \frac{40.48}{333.51/100} = BDT\ 12.41/kg$$

- Real prices are used to compare prices over time.

5

Nominal vs. real rice prices



- Nominal prices tend to rise with inflation, while real prices stay relatively "flat".
- Nominal and real prices cross in the base year (2005-06).
- The real price is a better indication of incentives to produce or consume.

6

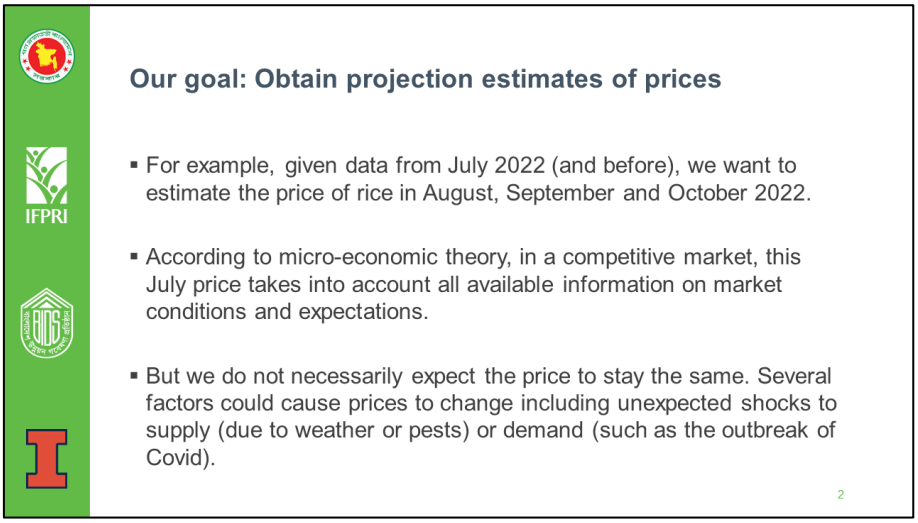
Another measure of price levels: GDP deflator

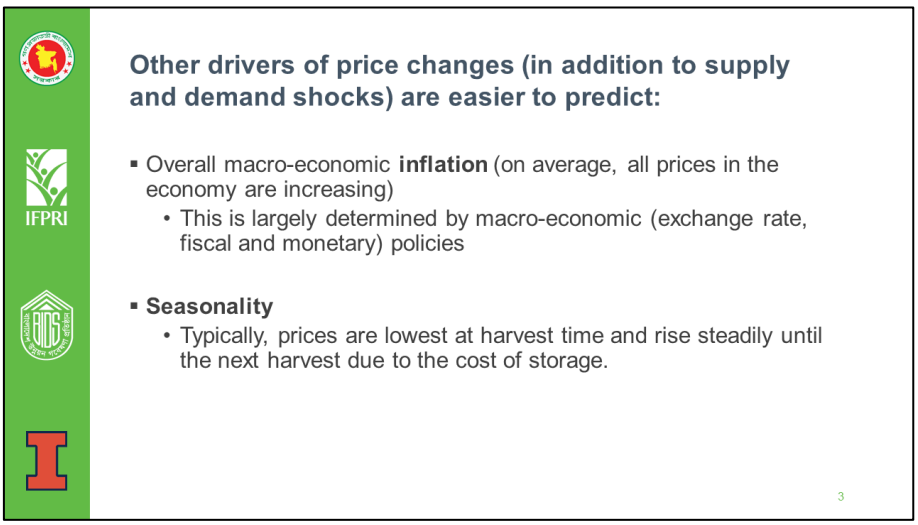
- In economics, the GDP deflator is a measure of the level of prices of all new, domestically produced, final goods and services in an economy in a year.
- GDP = gross domestic product, the total monetary value of all final goods and services produced within the territory of a country over a particular period (quarterly or annually).
- Like the CPI, the GDP deflator is a measure of price inflation/deflation with respect to a specific base year; the GDP deflator of the base year itself is equal to 100.
- Unlike the CPI, the GDP deflator is not based on a fixed basket of goods and services; the "basket" for the GDP deflator is allowed to change from year to year with people's consumption and investment patterns.

$$\text{GDP deflator} = \frac{\text{Nominal GDP}}{\text{Real GDP}} \times 100$$

7

5.8 Presentation 4: Manual for Price Analysis and Projections for Key Food Commodities





Ramadan

- In Ramadan, people eat certain items of food in larger quantities (e.g. sugar, oil, lentil, etc.). As a result, prices of those goods increase in Ramadan.
- Typically, these prices decline again after Eid.

4

The projection model

$$PP_{t+1} = P_t \times \frac{sf_{t+1}}{sf_t} \times Inf_{t+1} \times RF_{t+1}$$

PP_{t+1} : Projected Price for period t+1
P_t : Actual Price in period t
t : The current period; July 2022 in our example
$t+1$: The next period; August 2022 in our example
$\frac{sf_{t+1}}{sf_t}$: Seasonality factor
sf_{t+1} : Seasonality index for period t+1
sf_t : Seasonality index for period t
Inf_{t+1} : Rate of inflation for period t+1
RF_{t+1} : Ramadan Factor for period t+1

5

How do we estimate PP_{t+1} from the equation?

$$PP_{t+1} = P_t \times \frac{sf_{t+1}}{sf_t} \times Inf_{t+1} \times RF_{t+1}$$

- We start with P_t and multiply with $\frac{sf_{t+1}}{sf_t}$, Inf_{t+1} and RF_{t+1}
- Do we have P_t, $\frac{sf_{t+1}}{sf_t}$, Inf_{t+1} and RF_{t+1}?
  - We have the P_t, the current price. In our example, it is the price observed in July 2022.
- What about $\frac{sf_{t+1}}{sf_t}$, Inf_{t+1} and RF_{t+1}?

6

How do we estimate PP_{t+1} from the equation? (cont'd.)

- We do have Inf_{t+1} and RF_{t+1}
- We also have $Sf_{t+1}$and Sf_t , and we can construct the seasonality factor $\frac{sf_{t+1}}{sf_t}$
- However, we need to spend a little time understanding what $Inf_{t+1}, RF_{t+1}, \frac{sf_{t+1}}{sf_t}$ mean when data are involved and how we can construct them.

7

The seasonality factor: $\frac{sf_{t+1}}{sf_t}$

- As stated before, August prices could be different from July prices. We need to measure the "seasonality factor" by comparing August 2022 prices with July 2022 prices.
- But we only know prices in July 2022; August 2022 is still to come!
- We use what we know: we use July and August prices from a previous year.

8

The seasonality factor: $\frac{sf_{t+1}}{sf_t}$ (cont'd.)

- Which year? Can we use July 2021 and August 2021?
  - No. Remember, 2021 was a special year on account of the Covid-19 pandemic.
- What about July 2020 and August 2020?
  - 2020 was also a Covid year.
- Because any year can be a special year, we do not use July and August prices from a particular year. Rather we use **indexes** for July and August prices constructed with years and years of data; 10 years (120 months) 15 years (180 months), 20 years (240 months) or something similar.

9

The seasonality factor: $\frac{sf_{t+1}}{sf_t}$ (cont'd.)

- Time series data, especially price data can show a lot of ups and downs, known as **volatility**, from month to month.
- The volatility may persist even when the monthly data are averaged.
- Therefore, we construct **seasonality indexes** for each month.
- In our example, we'll need to construct seasonality indexes for July and August and obtain the seasonality factor by dividing one with the other.
- We'll need to have a clear understanding of the concepts of indexes and moving averages.
- **Please check the accompanying Excel file for a practical understanding of the concepts.**

10

Inf_{t+1}, Inflation, and RF_{t+1}, the Ramadan Factor

- **Inf_{t+1}, Inflation**
  - We need to know how general prices would increase in August 2022.
  - We cannot. August 2022 is still not here.
  - So, we use inflation data from the previous year; from 2021.
- **RF_{t+1}, the Ramadan Factor**
  - We calculate how prices in Ramadan months differ on average to prices in the previous (non-Ramadan) month.
  - If August 2022 is not a Ramadan month, the Ramadan Factor will not make a difference, and RF_{t+1} will have value of 1.
  - However, if August 2022 is a Ramadan month, RF_{t+1} will have a different value. We'll calculate the number.

11

Important concepts: Prices and moving averages

- We use historical monthly data for calculating the seasonality factor.
- However, monthly price data can be volatile.
- Assume that the price of rice in August 2008 is very high relative to the price in July 2008 on account of floods in Sylhet.
- But in September 2008, rice prices fell because of extra supplies.
- If we use actual monthly price data from July 2008 and August 2008, there would be large variations in price from month to month.
- Importantly, the variations would not be happening every year but only some of the time.
- We want to get rid of such wide variations. How?
- We divide the monthly data by its 6-month average, also known as the moving average.

12

Price Projections Excel File

- In the Excel file **"Price Projections_Training"**, we will be working on the **'Rice Proj 6MA (Jun-Nov22)'** sheet.
- Column A: Months
- Column B: Month-Year
- Column C: Monthly national wholesale price of coarse rice
- Column D: Monthly national wholesale price of medium rice
  - Source: Department of Agricultural Marketing (DAM).
- Column E: National food CPI data
  - Source: Monthly publication on price indexes from the Bangladesh Bureau of Statistics (BBS).

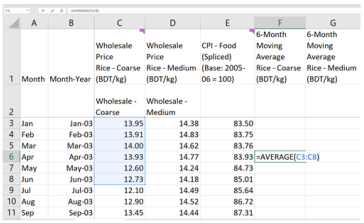
13

Step 1: Calculate the 6-Month Moving Average of Prices

- We will calculate the 6-month moving average of coarse rice prices in Column F, and the 6-month moving average for medium rice prices in Column G.
- We start with April 2003 (**cell F6**). The moving average price of this month will be the average of January to June 2003:

  =AVERAGE(C3:C8)
- We do the same for medium rice (**cell G6**):

  =AVERAGE(D3:D8)



	A	B	C	D	E	F	G
1	Month	Month-Year	Wholesale Price Rice - Coarse (BDT/kg)	Wholesale Price Rice - Medium (BDT/kg)	CPI - Food (Spliced) (Base: 2005-06 = 100)	6-Month Moving Average Rice - Coarse (BDT/kg)	6-Month Moving Average Rice - Medium (BDT/kg)
2			Wholesale - Coarse	Wholesale - Medium			
3	Jan	Jan-03	13.95	14.38	83.50		
4	Feb	Feb-03	13.91	14.83	83.75		
5	Mar	Mar-03	14.00	14.62	83.76		
6	Apr	Apr-03	13.93	14.77	83.93	=AVERAGE(C3:C8)	
7	May	May-03	12.60	14.24	84.73		
8	Jun	Jun-03	12.73	14.18	85.01		
9	Jul	Jul-03	12.10	14.49	85.64		
10	Aug	Aug-03	12.90	14.52	86.72		
11	Sep	Sep-03	13.45	14.44	87.31		

- Finally, we copy the formula over for the whole series, up to March 2022.

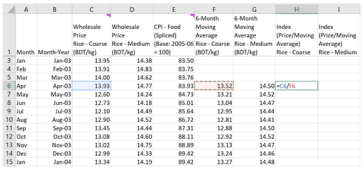
14

Step 2: Index of Actual Price to Moving Average

- We now create an index of the actual price to the moving average, to calculate the seasonality factor in later steps. This index is calculated as the actual price of rice in a month divided by the moving average price of rice for that month.
- For coarse rice, we type the following into **cell H6**:

  =AVERAGE(C6/F6)
- Repeat the same for medium rice in **cell I6**:

  =AVERAGE(D6/G6)



	A	B	C	D	E	F	G	H	I
1	Month	Month-Year	Wholesale Price Rice - Coarse (BDT/kg)	Wholesale Price Rice - Medium (BDT/kg)	CPI - Food (Spliced) (Base: 2005-06 = 100)	6-Month Moving Average Rice - Coarse (BDT/kg)	6-Month Moving Average Rice - Medium (BDT/kg)	Index (Price/Moving Average) Rice - Coarse	Index (Price/Moving Average) Rice - Medium
3	Jan	Jan-03	13.95	14.38	83.50				
4	Feb	Feb-03	13.91	14.83	83.75				
5	Mar	Mar-03	14.00	14.62	83.76				
6	Apr	Apr-03	13.93	14.77	83.93	13.52	14.50	=C6/F6	
7	May	May-03	12.60	14.24	84.73	13.21	14.52		
8	Jun	Jun-03	12.73	14.18	85.01	13.04	14.47		
9	Jul	Jul-03	12.10	14.49	85.64	12.95	14.44		
10	Aug	Aug-03	12.90	14.52	86.72	12.81	14.41		
11	Sep	Sep-03	13.45	14.44	87.31	12.88	14.50		
12	Oct	Oct-03	13.08	14.60	88.11	12.92	14.52		
13	Nov	Nov-03	13.02	14.75	88.89	13.13	14.47		
14	Dec	Dec-03	12.99	14.33	89.42	13.24	14.46		
15	Jan	Jan-04	13.34	14.19	89.42	13.27	14.48		

- Again, we copy the formula over for the whole series, up to March 2022.

15

Step 3: Annual Inflation

- For a given year, the point-to-point inflation is calculated as the percentage difference between the CPI in a given month and the CPI for the same month in the previous year.
- For example, the 2020 inflation rate is:

$$Inflation_{2020} = \frac{CPI_{December\ 2020}}{CPI_{December\ 2019}} - 1$$

- For 2020 inflation, we type the following in **cell I245**:

=$E$218/$E$206-1

	H	I	J	K
	Index (Price/Moving Average) Rice - Coarse	Index (Price/Moving Average) Rice - Medium	Monthly Inflation (Proportion)	Monthly Inflation (Proportion)
Inflation				
Y2020		=$E$218/$E$206-1		
Y2021				

- For 2021 inflation, we type the following in **cell I246**:

=$E$230/$E$218-1

16

Step 4: Monthly Inflation (as a proportion of annual inflation)

- We now need to distribute the annual inflation over a period of 12 months.
- We take the annual inflation figure for 2020 we calculated earlier in cell J245 and apply it to the month of January 2020.
- In **cell J207**, we type:

=(1+$J$245)^(1/12)

- For medium rice (**cell K207**):

=(1+$K$245)^(1/12)

- Copy the formula for remaining the months of 2020.
- We do the same for 2021, in **cells J219 and K219**:

=(1+$J$246)^(1/12)

=(1+$K$246)^(1/12)

	A	B	I	J	K
1	Month	Month-Year	Index (Price/Moving Average) Rice - Medium	Monthly Inflation (Proportion)	Monthly Inflation (Proportion)
219	Jan	Jan-21	0.991	1.004439	1.004439
220	Feb	Feb-21	1.003	1.004439	1.004439
221	Mar	Mar-21	1.024	1.004439	1.004439
222	Apr	Apr-21	1.046	1.004439	1.004439
223	May	May-21	0.980	1.004439	1.004439
224	Jun	Jun-21	0.970	1.004439	1.004439
225	Jul	Jul-21	0.995	1.004439	1.004439
226	Aug	Aug-21	1.015	1.004439	1.004439
227	Sep	Sep-21	1.006	1.004439	1.004439
228	Oct	Oct-21	0.996	1.004439	1.004439
229	Nov	Nov-21	0.998	1.004439	1.004439
230	Dec	Dec-21	0.985	1.004439	1.004439

17

Step 5: Seasonality Factor

- To construct this factor, we will use the index of the actual price to the 6-month moving average.
- For January, the seasonality index is the average of all the price indexes for all the January months in the entire series.
- We will therefore need to sum all the January indexes, and then divide by the number of January months in the entire series.
- We type the following in **cell L207** (coarse):

=SUMIF($A$6:$A$233, $A207, $H$6:$H$233) / COUNTIF($A$6:$A$233, $A207)

and **cell M207** (medium):

=SUMIF($A$6:$A$233, $A207, $I$6:$I$233) / COUNTIF($A$6:$A$233, $A207)

	A	B	H	I	J	K	L	M	N	O
1	Month	Month-Year	Index (Price/Moving Average) Rice - Coarse	Index (Price/Moving Average) Rice - Medium	Monthly Inflation (Proportion)	Monthly Inflation (Proportion)	Season Factor Rice - Coarse	Season Factor Rice - Medium	Ramadan Month Weight	Ramadan Index
204	Oct	Oct-19	0.978	0.981	Coarse	Medium	Coarse	Medium		
205	Nov	Nov-19	0.985	1.014						
206	Dec	Dec-19	1.005	0.992						
207	Jan	Jan-20	0.987	0.979	1.004346	1.004346	=SUMIF($A$6:$A$233,$A207,$H$6:$H$233)/COUNTIF(			
208	Feb	Feb-20	0.994	0.975	1.004346	1.004346	$A$6:$A$233,$A207)			
209	Mar	Mar-20	1.028	1.008	1.004346	1.004346				
210	Apr	Apr-20	1.016	1.060	1.004346	1.004346			0.5	
211	May	May-20	1.015	1.011	1.004346	1.004346			0.5	
212	Jun	Jun-20	1.048	1.035	1.004346	1.004346				
213	Jul	Jul-20	1.026	1.016	1.004346	1.004346				

18

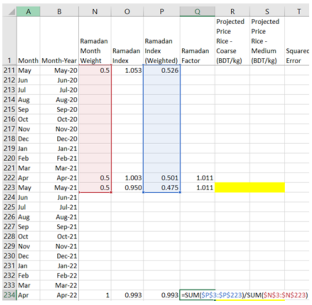
Step 6: Ramadan Factor

- In column N, we find the months of Ramadan for the entire series.
- If Ramadan was contained within one calendar month, the weight is 1; if two months, each month's weight is 0.5.
- We now create an index of the Ramadan price increase relative to its preceding month (**cell O222**):

  =C222/C221

- We then apply the Ramadan weight to this index in **cell P222:**

  =O222*N222



	A	B	N	O	P	Q	R	S	T
1	Month	Month-Year	Ramadan Month Weight	Ramadan Index	Ramadan Index (Weighted)	Ramadan Factor	Projected Price Rice - Coarse (BDT/kg)	Projected Price Rice - Medium (BDT/kg)	Squared Error
211	May	May-20	0.5	1.053	0.526				
212	Jun	Jun-20							
213	Jul	Jul-20							
214	Aug	Aug-20							
215	Sep	Sep-20							
216	Oct	Oct-20							
217	Nov	Nov-20							
218	Dec	Dec-20							
219	Jan	Jan-21							
220	Feb	Feb-21							
221	Mar	Mar-21							
222	Apr	Apr-21	0.5	1.003	0.501	1.011			
223	May	May-21	0.5	0.950	0.475	1.011			
224	Jun	Jun-21							
225	Jul	Jul-21							
226	Aug	Aug-21							
227	Sep	Sep-21							
228	Oct	Oct-21							
229	Nov	Nov-21							
230	Dec	Dec-21							
231	Jan	Jan-22							
232	Feb	Feb-22							
233	Mar	Mar-22							
234	Apr	Apr-22	1	0.993	0.993	=SUM($P$3:$P$223)/SUM($N$3:$N$223)			

- Next, the Ramadan factor – like seasonal factor (sum of all the weighted indexes divided by the number of Ramadan months):
- For April 2021 (**cell Q222**):

  =SUM($P$3:$P$211)/SUM($N$3:$N$211)

19

Step 7: Generating the Price Projections

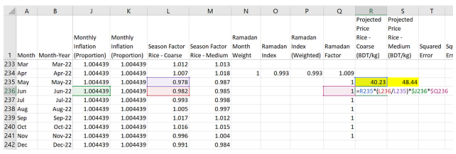
- We have actual price data up to May 2022, so we will generate a set of projections for the next 6 months – covering June to November 2022.
- The first component of the projection is the actual price in May 2022.
- In **cells R235 and S235** (highlighted in yellow), we are going to input the actual prices of coarse and medium rice:

  =C235 (in cell R235)

  =D235 (in cell S235)

- The first month for the projection is June 2022.
- For coarse rice (**cell R236**):

  =R235*(L236/L235)*$J236*$Q236



	A	B	J	K	L	M	N	O	P	Q	R	S	T
1	Month	Month-Year	Monthly Inflation (Proportion)	Monthly Inflation (Proportion)	Season Factor Rice - Coarse	Season Factor Rice - Medium	Ramadan Month Weight	Ramadan Index	Ramadan Index (Weighted)	Ramadan Factor	Projected Price Rice - Coarse (BDT/kg)	Projected Price Rice - Medium (BDT/kg)	Squared Error
233	Mar	Mar-22	1.004439	1.004439	1.012	1.013							
234	Apr	Apr-22	1.004439	1.004439	1.007	1.018	1	0.993	0.993	1.009			
235	May	May-22	1.004439	1.004439	0.978	0.987				1	40.23	48.44	
236	Jun	Jun-22	1.004439	1.004439	0.982	0.985				1	=R235*(L236/L235)*$J236*$Q236		
237	Jul	Jul-22	1.004439	1.004439	0.993	0.998				1			
238	Aug	Aug-22	1.004439	1.004439	1.005	0.997				1			
239	Sep	Sep-22	1.004439	1.004439	1.017	1.012				1			
240	Oct	Oct-22	1.004439	1.004439	1.016	1.015				1			
241	Nov	Nov-22	1.004439	1.004439	0.996	1.004				1			
242	Dec	Dec-22	1.004439	1.004439	0.991	0.984							

20

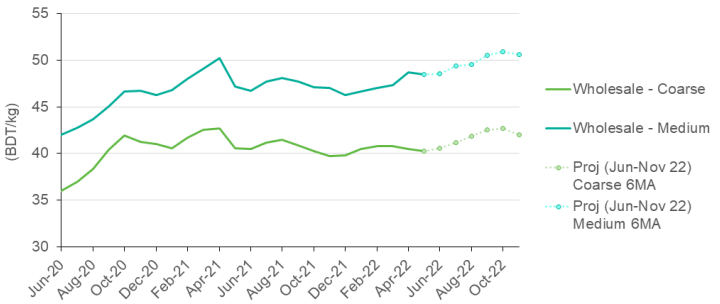
Step 7: Generating the Price Projections (cont'd.)

- For each of the subsequent months (July to November 2022), the formula will refer to the previous month.
- We can now copy over the formulas and generate the projection series for July to November and for medium rice.

	A	B	N	O	P	Q	R	S
1	Month	Month-Year	Ramadan Month Weight	Ramadan Index	Ramadan Index (Weighted)	Ramadan Factor	Projected Price Rice - Coarse (BDT/kg)	Projected Price Rice - Medium (BDT/kg)
233	Mar	Mar-22						
234	Apr	Apr-22	1	0.993	0.993	1.009		
235	May	May-22				1	40.23	48.44
236	Jun	Jun-22				1	40.54	48.54
237	Jul	Jul-22				1	41.21	49.39
238	Aug	Aug-22				1	41.88	49.57
239	Sep	Sep-22				1	42.56	50.54
240	Oct	Oct-22				1	42.69	50.91
241	Nov	Nov-22				1	42.03	50.57

21

Actual and Projected Prices: Coarse and Medium Rice



22

5.9 Presentation 5: Simulation Analysis of Supply, Demand and Prices

PRICE ANALYSIS AND PROJECTIONS FOR KEY FOOD COMMODITIES

Integrated Food Policy Research Program

Paul Dorosh, Razin Iqbal Kabir and Shoumi Mustafa

International Food Policy Research Institute

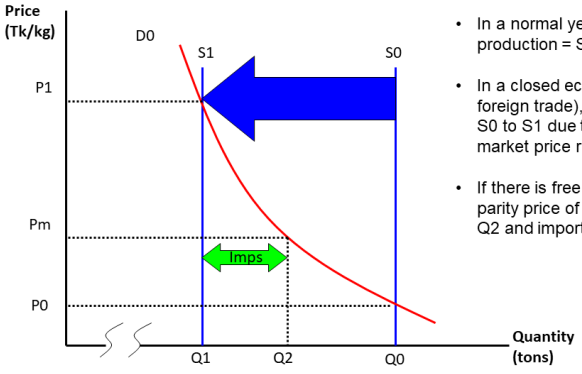
Dhaka, Bangladesh | July 20-21, 2022

Simulation Analysis of Supply, Demand and Prices

- Supply, demand and international trade
- Import parity, prices and imports
- Spreadsheet analysis of shocks with and without private imports

2

Short-run Impact of a Supply Shock



- In a normal year, domestic production = S0 and price = P0
- In a closed economy (i.e. with no foreign trade), if supply declines from S0 to S1 due to a weather shock, the market price rises to P1.
- If there is free trade with an import parity price of Pm, then total supply is Q2 and imports = (Q2-Q1)

3

Import Parity Calculations: 15% brokens (May 2022)

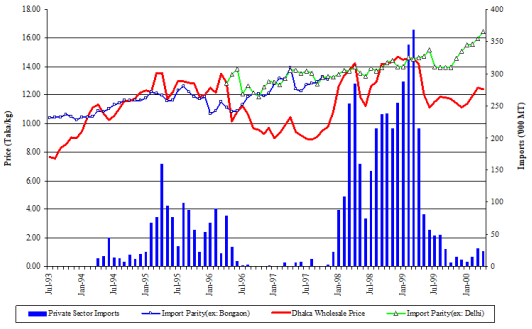
Pm = (PWM + shipping) * ER * (1 + tm) + domestic mktg costs

where

PW = Export price (fob Bangkok 15%)	$ 461/ton
Shipping = Shipping costs	$ 40/ton (35-45)
ER = Exchange Rate (Tk/USD)	89 Tk/$
PCIF = Import price Chittagong (Tk/kg)	44.6 Tk/kg
tm = import tariff (25% or 62.5%)	11.1 Tk/kg
Pm = Import parity price Chittagong (Tk/kg)	55.7 Tk/kg
Domestic marketing costs (Chit-Dhaka)	5.8 Tk/kg
Pm = Import parity price Dhaka	61.5 Tk/kg
Pm w/o import tariff	50.4 Tk/kg
Wholesale price medium quality (national average)	48.4 Tk/kg

4

Trade Liberalization and Private Sector Rice Imports: 1994-2000

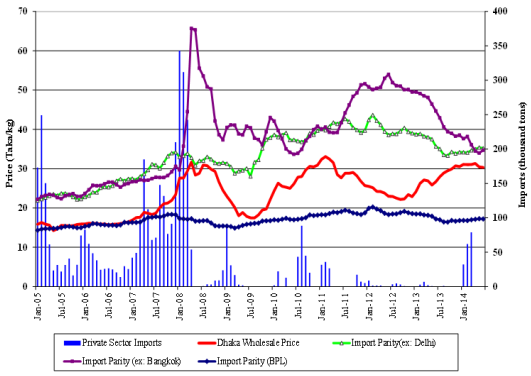


Source : Dorosh (2001).

- Bangladesh liberalized its import trade in rice in the early 1990s.
- In years of relatively poor harvests in the mid- to late 1990s, import parity prices provided a price ceiling for Bangladesh domestic market prices.
- Following the 1998 flood, private sector imports exceeded 200 thousand tons/month for seven consecutive months, stabilizing domestic prices at import parity (based on India **wholesale market** prices plus transport and marketing costs).

5

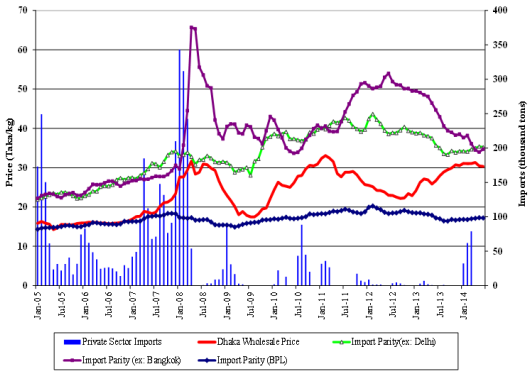
Price Stabilization through Subsidized Trade: 2002/03 to 2006/07



- In 2000/01 and again from 2002/03 to 2006/07, Bangladesh prices tracked import parity based on BPL sales prices.
- A specific Indian government program existed in 2002/3 for subsidized exports of rice obtained from FCI stocks at BPL prices.
- There were no explicit policy statements regarding export subsidies in later years. Econometric analysis shows that there was a statistically significant co-movement of wholesale and import parity prices in this period.

6

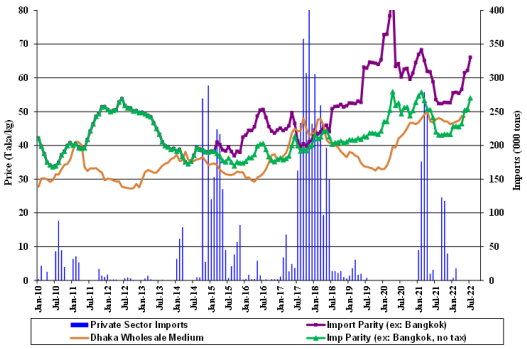
The World Price Shock of 2007/08



- In late 2007, world prices of rice and other cereals increased sharply as major exporters cut back export supplies.
- India initially banned private exports of non-basmati rice, but Bangladesh later negotiated a fixed volume of imports at a set price
- Bangladesh private sector imports from August 2007-April 2008 reached were 1.6 mn tons.
- Nonetheless, domestic prices in Bangladesh rose sharply.

7

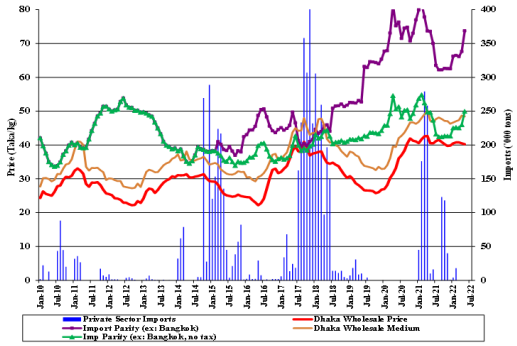
Bangladesh: Import Parity and Wholesale Prices of Rice, 2010-22



- In 2017 and early 2018, domestic wholesale prices rose to import parity levels, making private sector imports profitable.
  - Import tariffs were low, so import parity with and without tariffs were almost the same.
- In mid-2018, domestic wholesale prices fell due to a good harvest; import tariffs were also increased substantially, resulting in a wide gap between domestic prices and import parity.
- Domestic prices rose to import parity (w/o tariffs) in late 2020.

8

Bangladesh: Import Parity Prices and Rice Imports, 2010-22

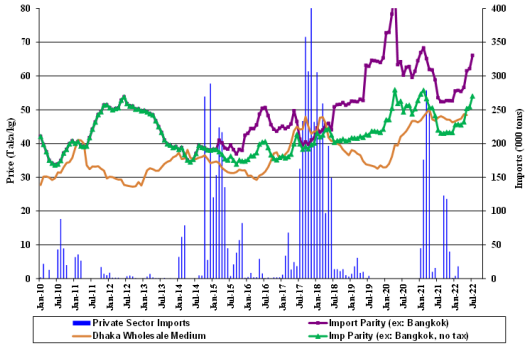


Wholesale prices of coarse rice and medium-quality rice move together, but medium-quality rice prices seem to be a better comparison with prices of imports.

- In 2017 and early 2018, domestic wholesale prices rose to import parity levels, making private sector imports profitable.
  - Import tariffs were low, so import parity with and without tariffs were almost the same.
- In mid-2018, domestic wholesale prices fell due to a good harvest; import tariffs were also increased substantially, resulting in a wide gap between domestic prices and import parity.
- Domestic prices rose to import parity (w/o tariffs) in late 2020.

9

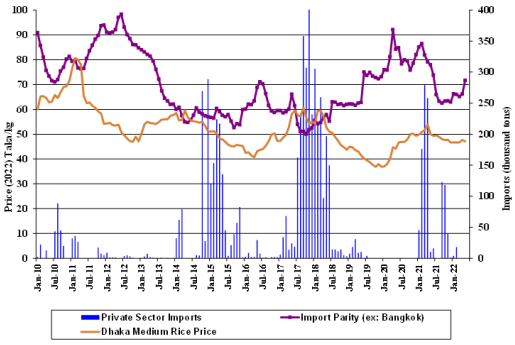
Bangladesh: Import Parity Prices and Rice Imports, 2010-22



- Domestic prices of medium quality rice rose to import parity (without tax) levels in early in 2021 and in mid-2022.
- Lowering of import tariffs for traders with successful tenders in 2021 helped make private sector imports possible.

10

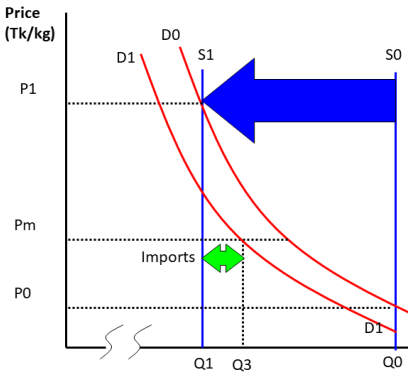
Bangladesh: Import Parity Prices (2022 Taka/kg) and Rice Imports, 2010-22



- Adjusting for inflation using the CPI as a deflator shows that real wholesale prices of rice trended downwards between 2010 and 2022.
- Consumers benefit from lower real rice prices.
- Lower real prices contribute to lower real incomes for producers.
  - However, other factors also influence real rice incomes including yields and input costs.

11

Short-run Impact of a Supply and Income Shock



Closed Economy with Income Shock:

(1) $S_1 = S_0 * (1+\text{shock})$

(2) $D_1 = D_0 * (P_1/P_0)^{\beta 1} * (Y_1/Y_0)^{\beta 2}$

(3) $S = D \Rightarrow S_0 = D_0$ and $S_1 = D_1$

$S_0 * (1+\text{shock}) = D_0 * (P_1/P_0)^{\beta 1} * (Y_1/Y_0)^{\beta 2}$

$\Rightarrow (1+\text{shock}) = (P_1/P_0)^{\beta 1} * (Y_1/Y_0)^{\beta 2}$

$\Rightarrow P_1/P_0 = [(Y_1/Y_0)^{\beta 2} / (1+\text{shock})]^{(1/\beta 1)}$

12

Short-run Impact of a Supply and Income Shock

			Nov-April	May-Oct
	2020/21	2021/22	2021/22	2022
	Data	Data	Base	Base
		Total	Aman	Boro,Aus
Production ('000 tons)	37.62	39.27	16.27	23.00
Aus ('000 tons)	3.29	3.00	0.00	3.00
Aman ('000 tons)	14.44	16.27	16.27	
Boro ('000 tons)	19.89	20.00		20.00
Losses, seed, etc. (10 percent)	3.76	3.93	1.63	2.30
Net Production	33.86	35.34	14.64	20.70
Domestic Procurement	1.450	1.820	0.200	1.620
Public Distribution	1.769	2.573	2.000	0.573
Net Govt Injections	0.319	0.753	1.800	-1.047
Private imports	0.786	0.304	0.063	0.267
Private stock change	0.000	0.000	0.000	0.000
Supply	34.96	36.40	16.51	19.92
Supply less private stock change	34.96	36.40	16.51	19.92

Closed Economy with Income Shock:

(1) $S_1 = S_0 * (1+shock)$

(2) $D_1 = D_0 * (P_1/P_0)^{\beta 1} * (Y_1/Y_0)^{\beta 2}$

(3) $S = D \Rightarrow S_0 = D_0$ and $S_1 = D_1$

$S_0 * (1+shock) = D_0 * (P_1/P_0)^{\beta 1} * (Y_1/Y_0)^{\beta 2}$

$\Rightarrow (1+shock) = (P_1/P_0)^{\beta 1} * (Y_1/Y_0)^{\beta 2}$

$\Rightarrow P_1/P_0 = [(Y_1/Y_0)^{\beta 2} / (1+shock)]^{(1/\beta 1)}$

- Base data is split by seasons (aman and boro/aus).
- Use PFDS data by month.
- Assume no change in private stock (but this assumption can be relaxed.)
- Supply = demand.

13

Short-run Impact of a Supply and Income Shock

	Nov-April	Nov-April	Nov-April	Nov-April	Nov-April	Nov-April
	2021/22	2022/23	2022/23	2022/23	2022/23	2022/23
	Base	Sim 1	Sim 2	Sim 3	Sim 2a-PM	Sim 2b-PM
	Aman	Aman	Aman	Aman	Aman	Aman
Production ('000 tons)	16.27	16.27	15.46	16.76	15.46	14.64
Aus ('000 tons)	0.00	0.00	0.00	0.00		
Aman ('000 tons)	16.27	16.27	15.46	16.76	15.46	14.64
Boro ('000 tons)						
Losses, seed, etc. (10 percent)	1.63	1.63	1.55	1.68	1.55	1.46
Net Production	14.64	14.64	13.91	15.08	13.91	13.18
Domestic Procurement	0.200	0.200	0.200	0.200	0.200	0.200
Public Distribution	2.000	2.000	2.000	2.000	2.000	2.000
Net Govt Injections	1.800	1.800	1.800	1.800	1.800	1.800
Private imports	0.063	0.063	0.063	0.063	0.392	1.124
Private stock change	0.000	0.000	0.000	0.000		
Supply	16.51	16.51	15.77	16.94	16.10	16.10
Supply less private stock change	16.51	16.51	15.77	16.94		
Demand	16.51	16.51	15.77	16.94	16.10	16.10
Per Capita Demand (kg/person/month)	16.66	16.66	15.92	17.11	16.26	16.26
Per Capita Supply (% change)	0.0%	0.0%	-4.4%	2.7%	-2.4%	-2.4%
Per Capita Income (21/22 = 100)	1.00	1.03	1.03	1.03	1.03	1.03
Income Elasticity of Demand		0.30	0.30	0.30	0.30	0.30
Per Capita Demand Income Effect		0.9%	0.9%	0.9%	0.9%	0.9%
Own Price Elasticity of Demand		-0.35	-0.35	-0.35	-0.35	-0.35
Income Adjusted Shift in Supply		-0.9%	-5.3%	1.8%	-3.3%	-3.3%
Real Price Change (ed = -0.3; ey = 0.3)		2.6%	16.8%	-4.8%	10.1%	10.1%

14

Priorities for Further Monitoring and Analysis

- Deeper understanding of private sector import trade
  - Monitor import parity and incentives (potential price ceiling following production shocks)
    - Import parity graphs as a tool: suggests policy options and highlights gaps in knowledge
  - Regular discussions with traders (trade barriers and tariffs actually paid, changes in transport and other costs, problems and concerns)
- Regular, timely dissemination of market information
  - FPMU / DG Food data bases
  - Food Situation Report
- Price analysis and forecasts
  - Understand the limitations: cannot predict shocks (by definition)
  - Use "confidence intervals" to highlight the uncertainty
  - Analyze a range of scenarios and policy options

15

References

Dorosh, Paul and Shahidur Rashid. 2013. "Trade Subsidies, Export Bans and Price Stabilization: Lessons of Bangladesh – India Rice Trade in the 2000s", Food Policy 41: 103-111 August. http://www.sciencedirect.com/science/article/pii/S0306919213000523

Dorosh, Paul A. 2001. "Trade Liberalization and National Food Security: Rice Trade between Bangladesh and India", *World Development*, 29(4): 673-689.

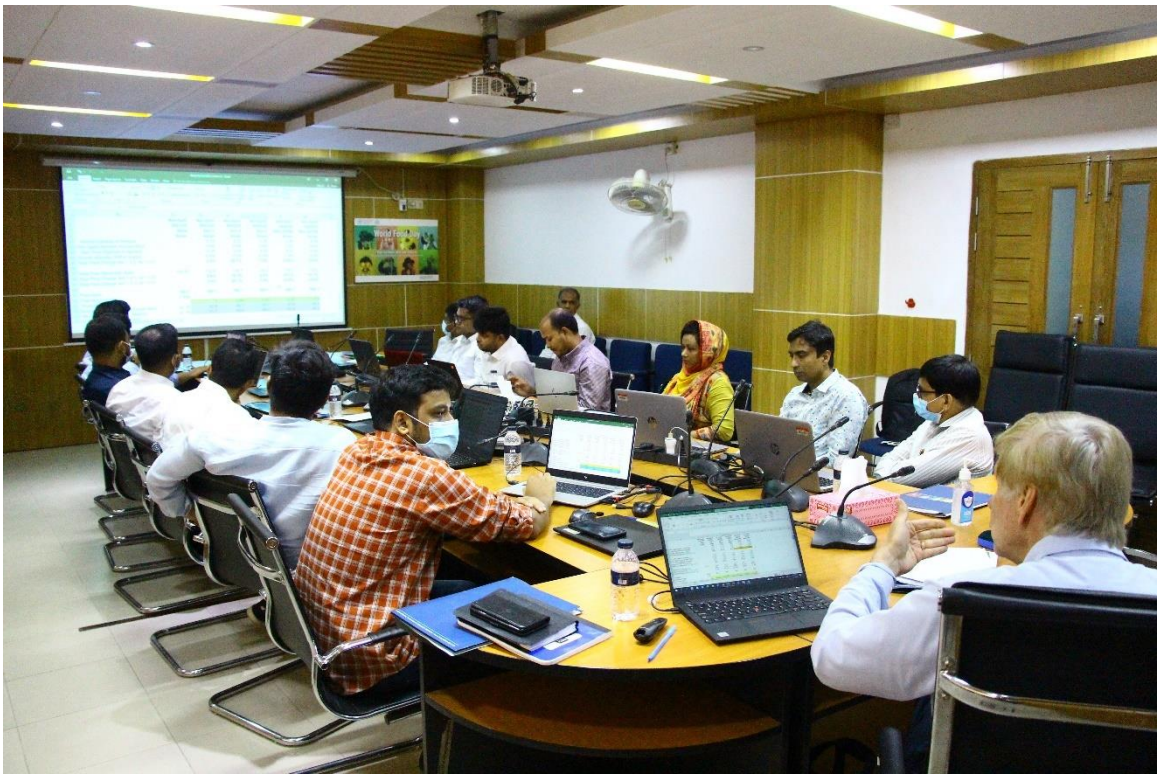
Dorosh, Paul A. 2009. "Price Stabilization, International Trade and National Cereal Stocks: World Price Shocks and Policy Response in South Asia", *Food Security* 1(2):137-149.

16

ANNEX 4. PHOTOS FROM THE TRAINING EVENT


MARKET PRICE ANALYSIS AND PROJECTIONS


FOOD PLANNING &




CONFERENCE ROOM
FOOD PLANNING & MONITORING UNIT (FPMU), MINISTRY OF FOOD
MARKET PRICE ANALYSIS AND PROJECTIONS


TRAINING ON
MARKET PRICE ANALYSIS AND PROJECTIONS
Integrated Food Policy Research Program (IFPRP)
Chief Guest: Md. Ismiel Hossain NDC
Secretary, Ministry of Food
Chair: Md. Shahiduzzaman Faruki
Director General, FPMU
Guest of Honor: Md Shakhawat Hossain
Director General, DG Food
Special Guest: Abdullah Al Mamun
Additional Director General, DG Food
Resource Person: Paul Dorosh, Ph.D., Director, Development Strategy and Governance Division, IFPRI
FPMU Conference Room, Dhaka, Bangladesh | July 20-21, 2022
INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
IFPRI


CONFERENCE ROOM
FOOD PLANNING & MONITORING UNIT (FPMU), MINISTRY OF FO
TRAINING ON
MARKET PRICE ANALYSIS AND PROJECTIONS
Integrated Food Policy Research Program (IFPRP)
Chief Guest:
Guest of Honor:
Special Guest
Chair:
Person: Paul Dorosh, Ph.D., Direct
FPMU Conferen
FPRI


FOOD PLANNING & MONITORI
TRAINING ON
MARKET PRICE ANALYSIS AN
Integrated Food Policy Research Progra
Chief Guest:
Reso
orosh, Ph.D., Director, Development Strategy
onference Room, Dhaka, Bangladesh | July 2

ACKNOWLEDGMENTS

The IFPRI-led JV highly appreciates the cooperation from the Food Planning Monitoring Unit (FPMU) in executing the Hands-on Training as part of the capacity building component of the deliverable. The event would not have been possible without FPMU's steadfast and timely cooperation as well as input. The IFPRP leadership is particularly grateful to the FPMU Director General, Mr. Shahiduzzaman Faruki, for efficiently formalizing the event in a very short period. The project also recognizes the contributions and active participation of the Ministry of Food (Hon. Secretary Mr. Md. Ismiel Hossain ndc), the DG Food (Mr. Abdullah Al Mamun), and DG FPMU (Mr. Shahiduzzaman Faruki). Special thanks to Sadat Anowar, Research Analyst, PHND, IFPRI-Dhaka; for taking the time and effort to provide support during the training program. From the JV side, the project leadership is also thankful to the IFPRI-Dhaka team for making the event a success.

Funding for this work was provided by the Modern Food Storage Facilities Project (MFSP) of the Bangladesh Ministry of Food under a World Bank loan. This publication has been prepared as an output of the Integrated Food Policy Research Program (IFPRP) and was undertaken as part of the CGIAR Research Program on Policies, Institutions and Markets (PIM) led by the International Food Policy Research Institute (IFPRI). It has not been independently peer reviewed. Any opinions expressed here belong to the authors and are not necessarily representative of or endorsed by IFPRI.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

A world free of hunger and malnutrition

IFPRI is a CGIAR Research Center

IFPRI Bangladesh, House 10A, Road 35, Gulshan 2, Dhaka, 1212, Bangladesh
T. + 880 2 222 298 686; + 880 2 222 293 434 | F. + 880 2 222 296 760 | Email: ifpri-ifprp@cgiar.org | bangladesh.ifpri.info