

Import Demand Function of Wheat and Future Trends

ABDUL GHAFOOR¹, ABEDULLAH[†], SHAHID BASHIR KHOKHAR[‡] AND SARVET HANIF[¶]

Departments of Marketing and Agribusiness and [†]Environmental and Resource Economics, University of Agriculture, Faisalabad–38040, Pakistan

[¶]United Bank limited, Faisalabad

[‡]Chamber of Commerce, Faisalabad

¹Corresponding author's e-mail: ghafooruaf@hotmail.com

ABSTRACT

The study was conducted to analyze the growth rates and forecasting of three important variables of the wheat economy in Pakistan i.e. production, procurement and imports. Time series data were used from 1970 to 2003. Import demand function of wheat was also calculated to establish a relationship between government procurement and wheat imports. The production growth of wheat was estimated for the period of 1970-1980, 1981-1990, and 1991-2003. Production grew at the rate of 5.37%, 3.11% and 2.09% for three decades, respectively. The growth rates of procurement were 14.6, 2.89 and 5.45% and for imports it was -5.03, 24.9 and 3.38%, for three decades, respectively. With respect to forecast of these three variables in the year 2015, the quantities of production will approach to 25 million tones with upper and lower critical limits of 23 and 27 million tones, respectively, the quantity of government procurement will reach to 7.2 million tones with upper and lower critical limits of 4.6 and 9.8 million tones, respectively and imports will reach to the level of 7.2 million tones with upper and lower critical limits of 4.6 and 9.8 million tones, respectively. Our import demand analysis supported the null hypothesis that irrespective of wheat production in the country, the amount of wheat procured by the Government significantly decreased the amount of wheat import.

Key Words: Demand function; Forecast; Growth rate; Procurement; Regression

INTRODUCTION

Wheat is staple food for a dominant portion of the Pakistan's population. It occupies a supreme position in food grains in Pakistan as it covers 66% of the total area under food grains and contributes 74% of the total food grain production. In the year 2003-04, wheat was grown on an area of 8176 thousand hectares with a production of 19,763 thousand tones. Wheat alone contributes 13.8% to the value added in agriculture and 3.4% towards Gross Domestic Product (GDP) of Pakistan (Anonymous, 2003-04). Punjab has got the lion's share in the production and area under wheat as it contributes 80% (15,355 thousand tons) in total production and 75% (6,097.3 thousand hectares) in total area (Anonymous, 2002-03).

At national level, the public wheat procurement accounts for 5,700 thousand tons i.e. 28.84% of total production (Anonymous, 2003-04). Assuming the market surplus share of wheat to be in range of 40 to 45%, approximately 1/3rd of the total marketed wheat does not enter the public marketing chain at all. A substantial portion of the remaining 2/3rd also enters the private marketing chain because the government releases the wheat stock to wholesale markets to stabilize price in lean months.

In the last four decades, except during 1964-65 and 1999-00 when the country harvested a bumper crop of wheat, the production always remained below than domestic demand. The country entered in surplus economy only in

the year 1999-2000, when the production crossed 21 million tones (21,079 thousand hectares) and, therefore, exported 0.197 million tones of wheat during 2000-01 (Anonymous, 2002-03). Continuously we are in deficit in wheat supply compared to local demands and it is compelling government each year to import wheat to fill the gap between demand and supply.

It has been observed that there is a strong relationship between imports and domestic procurement of wheat. Previous experience had shown that when government procured larger amounts of wheat from domestic markets then imports were on their declining trend and it indicated a negative relationship between the two. So as a policy option we need to clarify the exact relationship between the two variables so that an appropriate domestic procurement policy can be adopted.

So keeping in view the importance of past trends for future planning, it is evident to calculate the past growth rates of wheat in three dimensions i.e. production, procurement and imports. The growth rates of these three inter-related variables will assist to study the past inconsistency in policy parameters. This will also help in identifying the sources of gap between supply and demand and to develop policy parameters accordingly. This will further allow forecasting of wheat production, imports and procurement which will facilitate to develop concrete future policy parameters.

MATERIALS AND METHODS

Study was designed to explore three different dimensions of wheat economy in Pakistan i.e. growth rates, import demand function and forecast of future trends. The time series data, since 1970, for this purpose were collected from secondary sources like various issues of economic survey and agricultural statistics of Pakistan.

Growth trend. The growth trend of wheat production, procurement and imports of wheat were estimated through log-linear model by assuming the followings:

X_t = Production, procurement and imports of wheat in current year

X_0 = Initial value of Production, procurement and imports in base year

A familiar compound interest formula can be written as:

$$X_t = X_0(1+r)^t \quad (1)$$

Where r is the compound (i.e., over time) rate of growth of X_0 . Taking the natural logarithm of above equation we can write:

$$\ln X_t = \beta_0 + \beta_1 t \quad (2)$$

Where $\beta_0 = \ln X_0$, and $\beta_1 = \ln(1+r)$

The equation (2) can be modified by adding the disturbance as below.

$$\ln X_t = \beta_0 + \beta_1 t + u_t \quad (3)$$

The growth of targeted variable can be estimated by employing exponential or log-linear function. However, we employed log-linear function (as given in equation 3) to estimate the growth of production, procurement and imports of wheat and this specification commonly used to estimate growth rates of different variables. The equation (3) is also known as log-linear regression model (Gujarati, 2003). The coefficient of equation (3) is estimated by employing Statistical Package for Social Scientists (SPSS) and then finally the growth rate was estimated by taking the anti-log on both side of equation (3) which will generate $X_t = \text{antilog}(\beta_0 + \beta_1 t)$. This is also estimated by employing SPSS.

Forecast. Forecasts can be made by various methods like purely judgmental approaches, structural economic models, univariate time series models, multivariate time series models and econometric models. Economic models require detailed information to specify functional relations among different variables. Functional forms, which minimize subjective aspects of model construction, are becoming increasingly popular as a tool of data analysis among economists. Many economists have applied time series models for generating forecasts. Keeping in view the nature of study, available data, efficiency of the model to forecast, ARIMA model was selected to forecast the Production, procurement and imports of wheat.

The acronym ARIMA stands for “Auto Regressive Integrated Moving Average” model showing a combination of auto regressive and Moving average model. Lags of the differenced series appearing in the forecasting equation are called, ‘auto regressive’ terms, lags of the forecast errors are

called moving averages and a time series which needs to be differenced is said to be integrated version of stationary series. This method has been used extensively in economic research and employing the results of simpler ones has developed gradually more complex models.

A non-seasonal ARIMA model is denoted by ARIMA (p,d,q), according to Box and Jenkins (1976). Where, p is the order of the auto regressive process, d is the order of homogeneity, i.e. the number of differences to make the series stationary, q is the order of the moving average process.

The general form of ARIMA is:

$$\Delta^d Z_t = C + (\phi_1 \Delta^d Z_{t-1} + \dots + \phi_p \Delta^d Z_{t-p}) - (\Phi_1 a_{t-1} + \dots + \Phi_p a_{t-p}) + a_t \quad (4)$$

Where ‘ C ’ is a constant, Δ is a difference operator such that

$$\Delta Z_t = Z_t - Z_{t-1}, \Delta^2 Z_{t-1} = \Delta Z_t - \Delta Z_{t-1} \quad (5)$$

$Z_{t-1} \dots Z_{t-p}$ are past series values (lags), the ϕ is the coefficient to be estimated by auto-regressive model. The auto-regressive model of order ‘ p ’ denoted by AR (P) is:

$$Z_t = C + \phi_1 Z_{t-1} + \phi_2 Z_{t-2} + \dots + \phi_p \Delta^d Z_{t-p} + a_t \quad (6)$$

Where: a_t is a random variable with zero mean and constant variance. ϕ_s are coefficient in the moving average (MA) model, where as moving average model is of order ‘ q ’ or MA (q). This can be written as:

$$Z_t = a_t - \phi_1 a_{t-1} - \phi_2 a_{t-2} - \dots - \phi_p a_{t-p} \quad (7)$$

This model was employed to analyze the quantitative as well as qualitative relationship of data and to forecast the future trend of wheat production, procurement and imports up to year 2015. The forecasting was done by using SPSS.

Import demand function. Import of wheat depends on several factors, such as domestic production, procurement, floor prices and off take from Government stocks etc. Therefore, in order to estimate import wheat demand function a careful consideration of different variables is required. We have defined the import wheat demand function as below:

Wheat imports = F (domestic production, lagged values of procurement, procurement, off take from government stocks)

A simple linear model is estimated by using OLS for a period of 1970-71 to 2001-02 by employing SPSS.

RESULTS AND DISCUSSION

Growth rates. Production, procurement and imports are the three important variables of wheat economy in Pakistan. The growth rates tell us the rate at which these parameters grew in the past. Growth rates are explained in terms of percentage change per year in a particular year. The growth rate for the production during the decade of 1971-80 production of wheat grew at the rate of 5.37% per year and for the decades of 1981-1990 and 1991-2003, production increased at the rates of 3.11% and 2.09% respectively. In case of procurement the rate of growth in three decades was 14.6%, 2.89% and 5.45% respectively. The procurement increased at a faster rate in the decade of 1971-80 due to the

establishment of Pakistan Agricultural Storage and Services Corporation (PASSCO) and more emphasize of government of Pakistan was to procure from the farmers. The decade of 1981-90 was characterized with the lower production of wheat and also lower procurement of wheat at the same time but here we can note that growth rate for imports of wheat was at quite higher rate. The last decade was as era of mixed trends where government procurements increased at a modest rate. In case of imports, rate of growth was negative during the decade of 1970-80 and this can be seen with a downward movement of wheat imports which decreased from 218.5 thousand tones in the year 1971 to 96 thousand tones in the year 1980. In the next decade amounts of wheat imports increased at quite higher rate i.e. 24.9% per year and these were the years when the amounts of government procurement was quite low. In the last decade, imports increased at a rate of 3.38% per year showing a modest rate of increase. The detail of growth rates is given in Table I.

Forecasting. Using time series data, ARIMA model was applied in four steps as proposed by Box and Jenkins (1976) for the purpose of forecasting. These steps are as follows:

1. Model Identification: It was the specification of p, d, q.
2. Model estimation: It consisted of estimating the parameters of the model.
3. Diagnostic checking: It consisted of the application of a variety of tests to see whether the estimated model fits the data adequately.
4. Forecasts: Forecasts obtained at 95 % confidence interval with lower and upper limits.

Because most of the economic time series vary in a systematic way, the first step in identification was to choose and to check that the data were stationary or not. The time series data about production, procurement and imports of wheat were analyzed and auto-correlation function & partial auto-correlation function were estimated.

Originally, the time series was non-stationary. Auto correlation function did not fall as quickly as the lag K increases. To know the order of homogeneity of the time series data i.e., how many times the time series be differenced to have a stationary series, differenced time series and the auto correlation function of the differenced series were taken.

Correlogram of first differenced series of the auto-correlation function showed the properties of the stationary series. To check the further stationarity, second differenced time series also observed. Correlogram of the first differenced series showed appropriate stationary behaviour than the second differenced series. Auto correlation function fell as quickly as the lag K increased. Thus the selected value of "d" was 1 in all three cases. So the estimated ARIMA models for three variables are summarized in the Table II.

The forecasting for the production of wheat crop in Pakistan was done by using a ARIMA Model of p=2, d=1, q=1 with 95% confidence interval. It is quite evident from the table that the production of wheat is increasing in the

Table I. Growth rates (percentage per year)

Year	Production	Procurement	Imports
1971-80	5.37	14.6	-5.03
1981-90	3.11	2.89	24.9
1991-03	2.09	5.45	3.38

Table II. ARIMA Model specifications

Variables	p-value	d-value	q-value
Production	2	1	1
Procurement	1	1	1
imports	2	1	2

Table III. Forecasting of production (000 tonnes)

Years	Production forecast	Lower critical Limit	Upper critical Limit
2000-2001	19191.71	17447.71	20935.72
2001-2002	19967.50	18220.38	21714.62
2002-2003	20466.43	18716.04	22216.81
2003-2004	20784.17	19030.37	22537.98
2004-2005	21136.51	19384.11	22888.91
2005-2006	21486.12	19736.71	23235.52
2006-2007	21916.47	20156.89	23676.05
2007-2008	22341.11	20571.70	24110.52
2008-2009	22756.40	20979.83	24532.97
2009-2010	23173.08	21388.73	24957.42
2010-2011	23590.78	21798.01	25383.56
2011-2012	24008.25	22206.8	25809.70
2012-2013	24425.60	22615.22	26235.99
2013-2014	24842.99	23023.37	26662.62
2014-2015	25260.40	23431.23	27089.57

coming years. While discussing the results the upper and lower critical limits are also calculated for a comparison. According to results the production of wheat will increase to almost 22 million tones in the year 2006-07 with a lower critical limit of 20 million tones and upper limit of 23 million tones. In the final year of forecast the production of wheat is intended to reach at the level of 25 million tones with upper and lower critical limits of 23 and 27 million tones respectively. The detail of forecasted amounts of production is given in the Table III.

The forecasting for the procurement of wheat crop in Pakistan was done by using a ARIMA Model of p=1, d=1, q=1 with 95% confidence interval. The procurement of wheat is increasing in the coming years and this is quite compatible with the theoretical results because if the production is increasing then the procurement from the government will also increase accordingly. While discussing the results the upper and lower critical limits are also calculated for a comparison. According to results the procurement of wheat will increase to almost 6 million tones in the year 2005-06 with a lower critical limit of 3.6 million tones and upper limit of 8.3 million tones. In the final year of forecast the procurement of wheat is intended to reach at the level of 7.2 million tones with upper and lower critical limits of 4.6 and 9.8 million tones respectively. The detail of forecasted amounts of procurement is given in the Table IV.

Table IV. Forecasting of Procurement (000 tonnes)

Years	Procurement forecast	Lower Limit	critical Upper Limit	critical
2000-2001	5286.619	3009.421	7563.817	
2001-2002	5451.542	3172.391	7730.693	
2002-2003	5591.925	3289.004	7894.846	
2003-2004	5733.180	3409.894	8056.467	
2004-2005	5874.449	3529.924	8218.974	
2005-2006	6015.717	3649.044	8382.391	
2006-2007	6156.986	3767.276	8546.696	
2007-2008	6298.255	3884.648	8711.861	
2008-2009	6439.523	4001.184	8877.862	
2009-2010	6580.792	4116.910	9044.674	
2010-2011	6722.060	4231.849	9212.272	
2011-2012	6863.329	4346.028	9380.630	
2012-2013	7004.598	4459.470	9549.726	
2013-2014	7145.866	4572.199	9719.534	
2014-2015	7287.135	4684.238	9890.031	

Table V. Forecasting of Imports

Years	Imports forecast	Lower Limit	critical Upper Limit	critical
2000-2001	5450.128	3090.243	7810.013	
2001-2002	5422.511	3057.521	7787.501	
2002-2003	5593.987	3217.556	7970.418	
2003-2004	5733.054	3330.872	8135.236	
2004-2005	5874.110	3456.091	8292.128	
2005-2006	6014.114	3579.800	8448.427	
2006-2007	6154.112	3703.217	8605.008	
2007-2008	6294.072	3825.965	8762.179	
2008-2009	6434.028	3948.076	8919.981	
2009-2010	6573.983	4069.547	9078.420	
2010-2011	6713.938	4190.392	9237.483	
2011-2012	6853.892	4310.626	9397.158	
2012-2013	6993.846	4430.262	9557.431	
2013-2014	7133.801	4549.314	9718.288	
2014-2015	7273.755	4667.796	9879.714	

Table VI. Import Demand Function (Model Summary)

Ind. Variables	Coefficients	t-statistics	Significance
Constant	-1088.58	-2.801	0.010
Lagged procurement	-0.449	-3.779	0.001
Procurement	-0.495	-5.195	0.000
Off take from govt. stocks	0.469	2.652	0.015
Production	0.253	3.322	0.003
R ² = 0.81		Adjusted R ² = 0.77	f-statistics= 23

The forecasting for the imports of wheat crop in Pakistan was done by using an ARIMA Model of $p=2, d=1, q=2$ with 95% confidence interval. It is quite evident from the table that the imports of wheat are increasing in the coming years. A note worthy point from the results is that with forecast every indicator including production, procurement and imports is increasing. The reason for this is that with the time if production capacity of Pakistan will increase then definitely the demand of wheat will also increase in response to an increase in the population and for that government will have to import wheat for stabilization of the supplies in the country. According to results the

import of wheat will increase to almost 6 million tones in the year 2005-06 with a lower critical limit of 3.5 million tones and upper limit of 8.4 million tones. In the final year of forecast the import of wheat is intended to reach at the level of 7.2 million tones with upper and lower critical limits of 4.6 and 9.8 million tones respectively. The detail of forecasted amounts of imports is given in the Table V.

Import demand function. The import of wheat has been a matter of concern and controversy for Pakistan. To some extent it is considered to be a matter of political concern but practically it's a combination of both politics and economics. So it is imperative to find to out those factors, which affect the quantities of import in Pakistan. There will be a long list of factors, which affect the imports of wheat, but the question is not only to identify them but also to capture their individual effects on the quantities of imports. In Pakistan one of the important determinant of wheat imports is the level of domestic procurement and it is observed that whenever the government of Pakistan increased the quantities of domestic procurement, the quantities of imports decreased at those times (Hussain & Sampath, 2000). So a model of factors affecting the quantities of imports in Pakistan was analyzed to capture the effects of production, procurement and government stocks on the quantities of imports over the last thirty two years. The result of the analysis proved the relationship between imports and procurement and this is evident from the negative relationship, which exists between the two. As government always keeps some stock with it and these stocks are also affected by the leftover amount of the last year stock, so it was thought to consider one lag variable for the procurement with one degree difference. The variables listed in Table VI were found to be significantly affecting the change in imports as these variables explained 81% of total variation in imports over different time periods. The results of the study showed that whenever we will increase domestic procurement by one thousand tones the imports will decrease by 0.449 thousand tones. If we consider the effect of last year procurement then the amounts of imports will decrease by 0.495 thousand tones, indicating that last year procurement has stronger affect on current import than the current year procurement. The relationship of imports with production and off take from government stock was found to be positive. The positive relationship between imports and production can be justified by considering the impact of smuggling from Pakistan because high production within the country also leads to higher amount of smuggling. However, the exact relationship between two is always difficult to analyze because of the unavailability of data for smuggling. The summary of the results of import demand function is given in Table VI.

CONCLUSION AND RECOMMENDATIONS

Against to the general belief there is a strong positive relationship between local production of wheat and its

import which might be due high smuggling to Afghanistan and India. It is observed that import of wheat is strongly affected by the quantities of current and lag year procurement. Pakistan spends a huge amount of money on the import of wheat, which is not justifiable with the existing potential of production within the country. Pakistan can produce wheat in required amounts but then why Pakistan needs to import is a crucial question. This query can be solved by stopping the smuggling of wheat from Pakistan and also by increasing the level of domestic procurement. It should be noted that procurement also required additional budget to stock wheat for at least 10 months. Therefore, further research should concentrate to investigate the profitability of two options of import and procurement and on the basis of higher profitability or lower cost, best option should be chosen among the two. Past trends give us a good picture for understanding the past policies and their outcomes. So a fair picture of past trends for wheat in three dimensions i.e. production, procurement and import have been given in above discussion, which will be helpful in framing policies in the future. At the same time

forecasted amounts will keep us reminding that what target to achieve in the coming ten to fifteen years. As it is clear from the analysis that Pakistan needs to produce almost twenty seven million tones of wheat to fulfill its demand in the year 2015, so the government of Pakistan should take steps to boost up the production process along the lines.

REFERENCES

- Box, G.E.P. and G.M. Jenkins, 1976. *Time Series Analysis: Forecasting and Control*. Holdon-Day, San Francisco
- Anonymous, 2002-03. *Agricultural Statistics of Pakistan*. Ministry of Food Agriculture and Livestock. Economic Wing. Islamabad
- Gujarati, D.N., 2003. *Basic Econometrics*. pp. 840-1. McGraw-Hill Higher Education, New York.
- Anonymous, 2003-04. *Economic Survey*. Ministry of Finance, Economic Advisor's Wing. Islamabad.
- Hussain, I. and R.K. Sampath. 2000. On Some Aspects of Wheat Price Policy in Pakistan. *Ph. D. Thesis*. Department of Agricultural and Resource Economics. Colorado State University, Fort Collins, USA

(Received 15 March 2005; Accepted 19 July 2005)