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Econometric Simulation Model of Dal Industries for Forecasting and Policy Decision

R.B. Singh, Umesh Singh and B.L. Rajendra
Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur

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SUMMARY

The purpose of present study is to develop the econometric simulation model of Madhya Pradesh dal industry. The annual production data of pulse was taken from Directorate of Economics and Statistics, Govt. of Madhya Pradesh and Govt. of India. The data of population was taken from the Directorate of Census, Govt. of India. Four models were developed for domestic consumption of pulse, price of pulse, supply of pulse and price of milled pulse dal. Regression analysis and two stage least square analysis techniques were used to estimate the parameters. The estimated models were validated with the help of Theil inequality, root mean square error, mean absolute error and coefficient of determination (R_2). The result indicated that all the four models fits very well to the data sets. In all the four models, Theil inequality coefficient was almost zero and coefficient of determination (R_2) was almost equal to one, this indicates perfect prediction.

Keywords: Domestic pulse consumption, Theil inequality coefficient, RMSE, MAE, R^2.

1. INTRODUCTION

The production of pulses in India in 2010-11 is 18.2 million tons, which was about 27-28% of the world production. Among the different pulses grown in the country, the respective share of production has been: chickpea (Bengal gram/chana) 40.50%; pigeon pea (tur/ arhar) 17.90%; green gram (moong) 9.20%; black gram (urad) 9.10%; lentils (masur) 6.10% and other minor pulses 17.20% (Data source - FAO STAT 2013). Among the important states engaged in growing pulses have been: Madhya Pradesh 22.90%; Uttar Pradesh 18.12%; Maharashtra 14.25%; Rajasthan 10.84%; Andhra Pradesh 8.64%; Karnataka 5.76% and others 19.49%. Thus about 80.51% of the pulses supply is contributed by five major states (Data source - Directorate of Economics and Statistics 2013). Therefore in this study, a detailed econometric simulation model of the dal industry has been developed which helps in understanding and quantifying the magnitudes of relationships of major variables.

Jain and Naik (1998) have developed a detailed econometric simulation model of the Indian Cotton Industry. Vernon *et al.* (1969) described an econometric model of the American Tobacco Industry for the period through 1949 to 1966. The model contains 19 equations and is divided into three major blocks (1) leaf production (2) leaf price (3) cigarettes. Palanivel and Lawrence (1999) have discussed model to build a monetary sub sector for India and to evaluate the impact of changes in fiscal and monetary policies on output, inflation and trade flows during 1997/98 to 2001/2. Robeldo (2002) adopted a structural model for the U.S. wheat market and estimates four econometric

Corresponding author: R.B. Singh
E-mail address: r_bahadursingh@yahoo.com

specifications: a vector error-correction model without seasonal cointegration (VECM), a VECM with seasonal cointegration, a DSEM with cointegration (CDSEM), and a DSEM with seasonal cointegration (SCDSEM).

2. DATA SOURCES AND METHODOLOGY

The present study has confined to Madhya Pradesh state, which is in first position in production of pulses. The data of pulses has taken from the Directorate of Economics and Statistics of Government of Madhya Pradesh and Government of India. The data of population was taken from the Directorate of Census, Government of India. The rate of population growth of Madhya Pradesh was taken.

2.1 Specification of Models and Estimation of Parameters

Total demand for pulse at time t (DP_t) is the cumulative demand for dal for domestic consumption (DCP_t), export and domestic stock of pulse ($EDSP_t$) at time 't'. Since an inverse function of pulse has been specified, market equilibrium identity has been used to explain domestic consumption of pulse. It has been explained as the difference between supply of pulse (SP_t) and export and domestic stock of pulse at time 't' ($EDSP_t$).

$$DCP_t = \beta_1+\beta_2\, SP_t - \beta_3\, EDSP_t$$

Export and domestic stock of pulse has been considered as exogeneous variable in the system. Processing of pulse dal (DPP_t) at time 't' is a function of domestic consumption of pulse, price of pulse ($DPPY_t$) and its own previous year price at time t (DPP_{t-1}).

$$DPP_t = \beta_1+\beta_2\, DCP_t + \beta_3\, DPPY_t + \beta_4\, DPP_{t-1}$$

Supply of pulse at time t is the sum of product of pulse (PdP_t), import of pulse (IP_t) and domestic stock of pulse carried over from the previous year (DSP_{t-1}), at time 't'. Because of excess supply of pulse in Madhya Pradesh, import of pulse is assumed zero.

$$SP_t = \beta_1+\beta_2\, PdP_t + \beta_3\, DSP_{t-1}$$

An inverse demand function of milled pulse dal has been specified. Price of milled pulse dal at time 't' ($DPMPF_t$) is a function of demand for milled pulse dal ($DMPF_{t-1}$) and one year lagged price of milled pulse dal ($DPMPF_t$) and price of pulse ($DNTMP_t$).

$$DPMCF_t = \beta_1+\beta_2\, DMPF_t + \beta_3\, DPMPF_t + \beta_4\, DNTMP_t$$

3. RESULTS AND DISCUSSION

3.1 Estimation by Regression Analysis

3.1.1 Domestic Consumption of Pulse

$$DCP_t = 9704690.928 + 0.138SP_t - 0.155EDSP_t$$

SE 1421186 0.067 0.065

The estimate of this equation suggest that domestic consumption of pulse depends upon the pulse grown by the farmer itself and the domestic consumption depends very minimum from the supply side which is only 13%, while export and domestic stock of pulse ($EDSP_t$) implies that stock of pulse for supply is very limited, which is only 15%. The curve is the best fit since the Theil inequality coefficient is almost zero and the graph of domestic consumption versus time shows the linear trend almost constant. This shows the domestic consumption of pulse does not increase over time as population increases and resulted in less consumption.

3.1.2 Price of Pulse Dal

$$DPP_t = 6245.897 - 0.0006DCP_t - 2.27DPPY_t + 5.9DPP_{t-1}$$

SE 4345.572 0.0005 1.67 2.11

The model fitted for price of pulse dal as endogenous variable and DCP_t, $DPPY_t$ and DPP_{t-1} as exogeneous variables, shows that the domestic consumption of pulse with respect to price of pulse dal is non-significant. It can be seen from the equation that previous years price of pulse affects the price of pulse dal. So we can say that price of pulse dal is not affected by the domestic consumption, but it is affected by previous years price of pulse. This model is best fitted as Theil inequality coefficient is almost zero (Table 1). The graph of price of pulse dal versus time (Fig. A.2).

3.1.3 Supply of Pulse

SP_t = -2.342E-06 + 1.00 PdP_t + 1.0 DSP_{t-1}

SE 9.801E-07 8.29E-14 2.03E-13

In this model import of pulse is assumed zero because, in Madhya Pradesh there is excess production of pulse. The supply of pulse is perfectly affected by production of pulse at time '*t*' and domestic stock of pulse carried over from previous year. From the Table 1 we can increase the supply at time '*t*'. This linear trend can be observed from the graph in Fig. A.3.

3.1.4 Price of Milled Pulse Dal

$DPMCF_t$ = 108.302 – 1.9E-05 $DMPF_t$+ 0.06$DPMPF_t$ +1.47 $DNTMP_t$

SE 4.94 E-10 7.89E-17 2.32E-13 3.99 E-13

Table 1. Results of Goodness of Fit of the Four Models Estimated by Regression Analysis

Tests / Models	Theil Inequality Coefficient	RMSE	MAE	R^2
Domestic Consumption of Pulse	0.023	500254.6	434654	0.446
Price of Pulse Dal	0.045	105.0095	73.49331	0.748
Supply of Pulse	0.00	1.153E-07	9.54E-08	1.00
Price of Milled Pulse Dal	0.0044	8.944	6.00	0.9968

Here we can observe from this model that the one year lagged price of mill pulse dal ($DPMPF_t$) and price of pulse have positive effect on the price of milled pulse dal where as the effect of demand for milled pulse dal is negative. From the Table 1, we can see that this model fits very well to the data set as the Theil inequality coefficient is 0.0044 which is very near to zero and coefficient of determination is 0.996 which is almost equal to 1.00. RMSE and MAE is also very less which indicates that this model fits very well. We can say from this model that by increasing the price of pulses and by increasing the domestic consumption of pulse, we can increase the price of milled pulse dal, which is very beneficial to farmers. This linear trend can be observed from the graph in Fig. A-4.

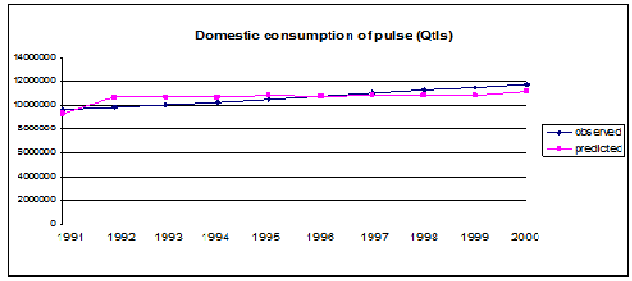

Fig. A.1. Graph Showing Observed and Estimated Values of Domestic Consumption of Pulse

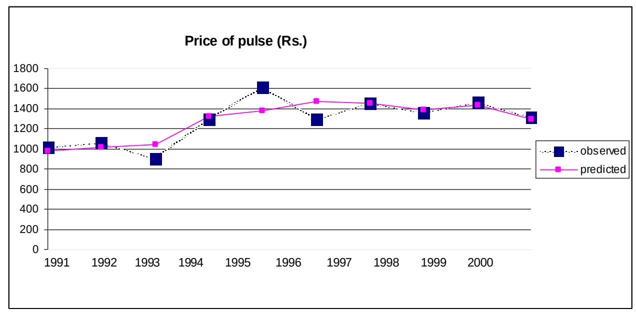

Fig. A.2. Graph Showing the Observed and Estimated Values of Price of Pulse

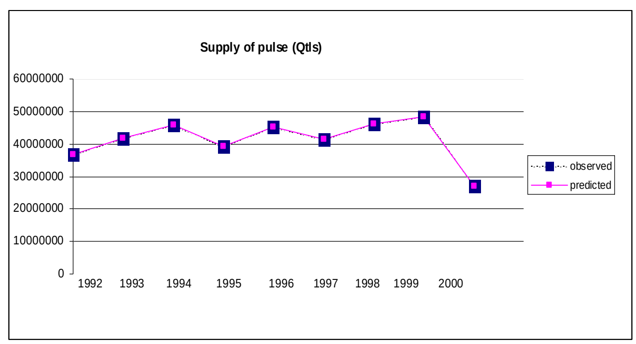

Fig. A.3. Graph Showing Observed and Estimated Values of Supply of Pulse

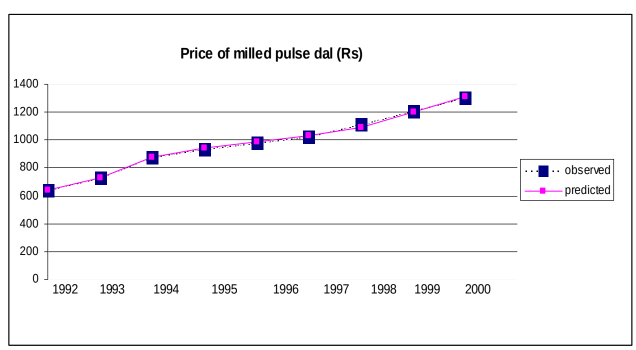

Fig. A.4. Graph Showing Observed and Estimated Values of Price of Milled Pulse Dal

3.2 Estimation by the Method of Two Stage Least Square Regression Analysis

3.2.1 Domestic Consumption of Pulses

DCP_t= 9704690.928 + 0.138SP_t - 0.155$EDSP_t$

SE 5.602E-8 2.67E-15 2.60E-15

Here we can observe that the coefficients obtained are same as the coefficients that were obtained by the method of regression analysis. But the standard error of coefficients is very less in this model in comparison to the standard error of coefficients obtained by regression analysis. The goodness of fit statistic Theil inequality coefficient of this economic model is very negligible i.e. almost zero (Table 2), and the coefficient of determination is 1.00 (Table 2), which indicates that this model yields perfect prediction. We can say from this model that, by increasing the supply of pulse we can increase the domestic consumption of pulse. The production of pulse can be increased by increasing the area under pulse cultivation and increasing use of higher yielding varieties. This linear trend can be observed from the graph Fig. B.1.

3.2.2 Price of Pulse Dal

DPP_t= 6245.897- 0.0006DCP_t - 2.27$DPPY_t$ + 5.9DPP_{t-1}

SE 3.2E-09 4.06E-16 1.24E-12 1.56E-12

We can observe from the estimation of this model that the intercept and slopes are same as that of intercept and slopes of regression analysis. But the standard error is very negligible in comparison to the standard error obtained from regression analysis. The goodness of fit statistic Theil inequality coefficient of this economic model is almost zero (Table 2), and the coefficient of determination is 1.00 (Table 2). The RMSE and MAE are almost equal to zero. This indicates that this model fits very well to the data set. We can comprehend from the estimates of this econometric model that by increasing the price of pulse at time '*t*-1', we can increase the price of pulse dal at time '*t*'. This linear trend can be observed from the graph in Fig. B.2.

3.2.3 Supply of Pulse

SP_t = 4.35E-06 + 1.00 PdP_t + 1.0 DSP_{t-1}

SE 2.81E-06 2.38E-13 5.835E-13

Here we can observe that all coefficients are positive, which was not the case in the parameters estimated by regression analysis. From the Table 2, we can see that Theil inequality coefficient is almost zero and coefficient of determination is 1.00, which indicates the perfect prediction. In this model the RMSE and MAE are very negligible. The estimates of this econometric model indicates that by increasing the production of pulse and domestic stock of previous years of the pulse, we can increase the supply of pulse. This linear trend can be observed from the graph in Fig. B.3.

3.2.4 Price of Milled Pulse Dal

$DPMCF_t$ = 108.302 – 1.9E-05 $DMPF_t$+ 0.06$DPMPF_t$ +1.47 $DNTMP_t$

SE 4.94 E-10 7.89E-17 2.32E-13 3.99 E-13

Table 2. Results of Goodness of Fit of the Four Models Estimated by Two Stage Least Square

Tests / Models	Theil Inequality Coefficient	RMSE	MAE	R^2
Domestic consumption of pulse	9.23E-16	1.97E-08	1.42E-08	1.00
Price of pulse dal	3.00E-14	7.76E-11	6.62E-11	1.00
Supply of pulse	4.20E-15	3.33E-07	2.77E-07	1.00
Price of milled pulse dal	8.56E-15	2.90E-22	1.41E-11	1.00

The estimates of this model suggest that the coefficient is same as that of the coefficients estimated by regression analysis. The standard error of all the estimates in this estimation is very less, which indicates its goodness of fit. From the Table 2. We can see that all the goodness of fit statistics Theil inequality coefficient, RMSE and MAE are almost equal to zero and coefficient of determination is 1.0. This indicates that this model results in perfect prediction. This linear trend can be observed from the graph in Fig. B.4. by increasing the price of pulse we can increase the price of milled pulse dal, which helps farmers to increase their income.

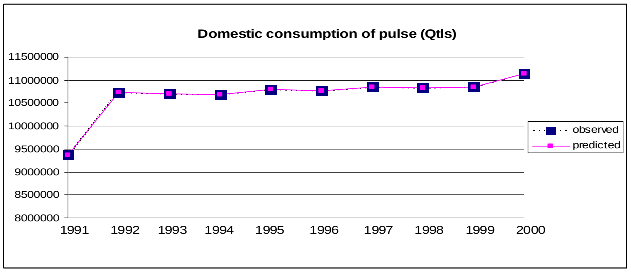

Fig. B.1. Graph Showing Observed and Estimated Values of Domestic Consumption of Pulse

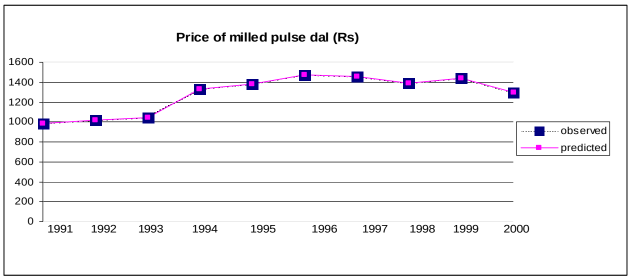

Fig. B.2. Graph Showing the Observed and Estimated Values of Price of Pulse

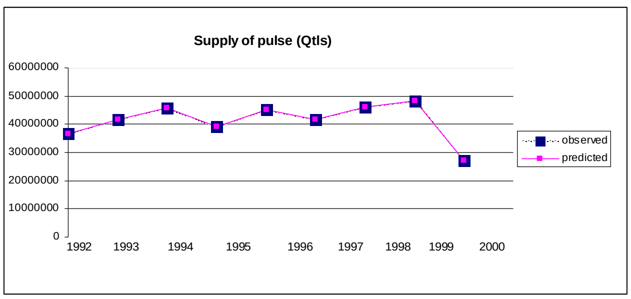

Fig. B.3. Graph Showing Observed and Estimated Values of Supply of Pulse

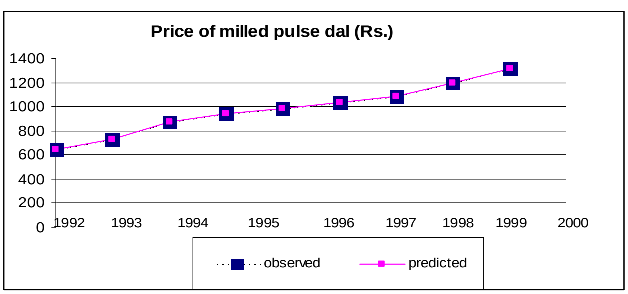

Fig. B.4. Graph Showing Observed and Estimated Values of Price of Milled Pulse Dal

4. CONCLUSION

From the above study we may conclude that,

1. The econometric model of domestic consumption of pulse $DCP_t = \beta_1 + \beta_2 SP_t - \beta_3 EDSP_t$ fits very well into the data set which has been validated by four goodness of fit tests. It can be concluded that by increasing the supply we can increase the consumption. The production of pulse can be increased by increasing the area under cultivation of pulse. This results in increase in the supply which will lead to increased domestic consumption.

2. The model $DPP_t = \beta_1 + \beta_2 DCP_t - \beta_3 DPPY_t + \beta_4 DPP_{t-1}$ of price of pulse dal yields perfect prediction which is validated by the four goodness of fit tests. It can be conclude that increase in price of pulse leads to increase in the price of pulse dal.

3. The econometric model $SP_t = \beta_1 + \beta_2 PdP_t + \beta_3 DDP_{t-1}$ of supply of pulse fits very well into the data set and results in perfect prediction, which is validated by four goodness of fit tests. We conclude that the production at time '*t*' and price of time '*t*-1' determines the supply of pulse.

4. The econometric model $DPMCF_t = \beta_1 + \beta_2 DMPF_t + \beta_3 DPMPF_t + \beta_4 DNTMP_t$ of price of milled pulse dal fits perfectly in to the data set. This has been validated by four goodness of fit statistics. we can concluded from price of pulse at time '*t*' and one year lagged price of pulse dal affects the endogenous variable price of milled pulse dal ($DPMCF_t$).

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