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## **Foodgrain Price Policies in India: The effects on Foodgrain Production and Rural Poverty**

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## Abstract

There is a large research literature which quantifies the important contributions of public, private and human capital to economic growth and poverty reduction.

## Keywords

Foodgrain, Price, Policies, India, effects, Foodgrain, Production, Rural, Poverty

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**FOODGRAIN PRICE POLICIES IN INDIA:  
THE EFFECTS ON FOODGRAIN PRODUCTION AND  
RURAL POVERTY  
WILSON, E. J. \***

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***Abstract***

There is a large research literature which quantifies the important contributions of public, private and human capital to economic growth and poverty reduction. However, studies based on the endogenous growth model tend to exclude the effects of relative prices on economic growth. This paper develops a simple growth model which details the effects of minimum producer support prices and maximum consumer issue prices on Indian foodgrain production and rural poverty, subject to a long run government budget constraint. The major structural changes in the non-stationary variables are endogenously identified over the period 1951 to 2001 and the Johansen FIML procedure is used to derive efficient estimates of important long run elasticities. It is found that a one per cent increase in the real minimum producer support price for wheat will increase real foodgrain production per rural worker by 1.3 per cent in the long run. Similarly, a one per cent reduction in the real consumer maximum issue price for wheat (via the public distribution system) will reduce the rural head count poverty ratio by 1.3 per cent in the long run. The government budget constraint applies in the long run whereby a one per cent increase in the minimum producer support price requires the consumer maximum issue price to increase by 1.5 per cent. However, these prices can be moved in opposite directions to reduce poverty in the short run. A one per cent increase in the minimum producer support price is found to Granger cause the maximum issue price to fall by 1.1 per cent in the next year.

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This dynamic growth analysis confirms that price policy in India since independence has importantly promoted the production of foodgrain and contributed to the reduction in rural poverty. Prices can be powerful policy instruments and the elasticity estimates contained here certainly support this view.

*JEL Classifications:* O11, Q18, C22.

*Keywords:* foodgrain production, price policies, economic growth, rural poverty.

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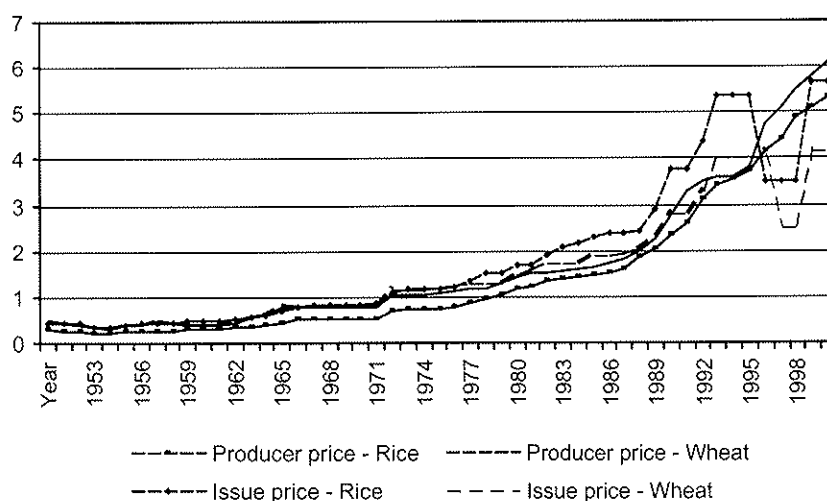
## **1. Introduction**

The Prime Minister of India, Mr Manmohan Singh, has promised a “New Deal” for rural India in his address to the nation on 24<sup>th</sup> June, 2004. The Minister for Finance, Mr P. Chidambaram, said in his Budget Speech for the Union Budget 2004-05 that this “New Deal is not only essential for rural development and welfare, but also essential for achieving sustained overall annual growth of 78 per cent”. This goal is listed as the first of seven economic objectives in the new government’s National Common Minimum Program (NCMP). Two other objectives are: “focussing on agriculture and infrastructure” and “accelerating fiscal consolidation and reform”.

This paper reviews the role of producer and consumer price support schemes in promoting the production of foodgrain and the reduction of rural poverty. An important element in the analysis is the inclusion of the government budget constraint in the growth process. It is well understood that increases in strategic agricultural infrastructure significantly boosts long term growth in agricultural output and productivity. The studies by Chaudhri and Wilson (2004, 2002, 2001b) document these benefits based on the time series estimation of endogenous growth models. Given the long term nature of these models they rely on the conceptualisation and empirical quantification of real stock and flow effects. Indeed Chaudhri and Wilson (2001a) include the real values in Rp currency terms to allow the estimation of the fiscal budget constraint, whereby the

government must trade-off longer term development spending for shorter term spending to relieve poverty. However, to the best of the author's knowledge, the effects of pricing policies are usually not included in this time series analysis. Chaudhri and Wilson (2004) and Wilson (2005) model the effects of real agricultural prices on economic growth and poverty. The degrees of Indian market integration in wheat, rice and jowar and the role of agricultural prices in coordinating markets have been studied by Wilson (2003, 2002, 2001). Since India gained independence in 1947, there has been a cumulative increase in the minimum support prices for producers and maximum issue prices for consumers in wheat and rice. Figure 1 graphs the prices for these two cereals and it is clear that there are relatively large variations in the issue prices since the early 1990s.

Figure 1. Producer Minimum Support and Consumer Maximum Issue Prices



This paper explores the consequences of these long run and short run developments in prices on foodgrain production and rural poverty. The next section formalises the key endogenous growth relationships to be estimated whilst Section 3 analyses the non-

stationarity properties of the time series. Importantly, this is done using Perron's (1997) method which allows for the endogenously determined structural breaks in the series. Section 4 uses Johansen's method of estimating the long run elasticities using cointegration methods in a small simultaneous model. The final section summarises the findings and discusses some of the policy implications.

## 2. The Model

The model of Wilson (2005) is developed to explore the relationships between the minimum producer support price, maximum consumer issue price, foodgrain production, the public distribution of foodgrain and rural poverty in a dynamic growth context. Each rural household selects the time path of real consumption per person, denoted  $c$ , to maximise the standard concave felicity function:  $u(c) = \int_{t_0}^{\infty} u[c(t)] e^{-\rho t} dt$ , with constant discount rate  $\rho$ . The household budget constraint is:<sup>1</sup>  $\dot{k} + c = w + rk - \tau$ , where  $\dot{k}$  is per capita investment,  $rk$  is the household's income from capital per person,  $k$  with  $r$  the real rate of interest.<sup>2</sup> The per capita wage income is denoted  $w$  and the per capita tax paid by the rural household to the government is  $\tau$ .

Rural household income from production, in the form of per capita wage income and the return to capital will be equal to per capita household production:  $w + rk = y$ . Making the simplifying assumption that a proportional tax rate,  $0 < \alpha_t < 1$ , applies to

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<sup>1</sup> The prime represents differentiation with respect to the relevant explanatory variable, for example  $u'(c) = \partial u(c) / \partial c$ . The dot above the variable represents differentiation with respect to time,  $\dot{k} = \partial k / \partial t$ . The time subscript will be discarded where possible, in order to simplify the notation.

<sup>2</sup> We assume that these household's do not own land and are unable to borrow.

household income allows  $\tau$  to be substituted out to give the simplified household budget constraint:  $\dot{k} + c = \alpha y$  with  $\alpha = 1 - \alpha_\tau$ .

Some of the household per capita production,  $y_s$ , valued at market price,  $p^*$ , will be purchased by the government at the minimum support price  $p_s$ . The balance of the household's production,  $y_{ns}$ , is assumed to be sold on the open market, at market price  $p^*$ .

This gives the relationship:

$$y = (y_{ns}/p^*)p^* + (y_s/p^*)p_s = y_{ns} + y_s(p_s/p^*).$$

The government also publicly distributes per capita nominal output for consumption,  $c_i$ , by the rural household at the maximum issue price,  $p_i$ . The household also purchases  $c_{ni}$  from the open market at free market price  $p^*$ . Real per capita consumption is therefore given by:  $c = c_{ni} + c_i(p_i/p^*)$ .

The government budget constraint includes the government purchases of household production at the minimum support price and per capita government expenditure,  $g$ :  $g + y_s(p_s/p^*) = \tau + c_i(p_i/p^*)$ . Government revenue comprises the sales,  $c_i$  of output at the maximum issue price,  $p_i$  and per capita taxation receipts,  $\tau$ .

The household production function:  $y = Af(k, g, p_s/p^*)$  includes the effects of total factor productivity,  $A$ , real per capita capital,  $k$  and government expenditure,  $g$  as well as the relative minimum support price,  $p_s/p^*$ .

Rural households maximise their intertemporal utility,  $u(c)$  with respect to the household budget constraint,  $\dot{k} + c = \alpha y$ . This is achieved by maximising the Hamiltonian:  $H = u(c)e^{-\rho t} + q\dot{k}e^{-\rho t}$  with costate variable,  $qe^{-\rho t}$  expressed as the net present value of Tobin's  $q$ . This maximisation derives the solution:

$q = \int_t^\infty (\alpha \partial y / \partial k) e^{-r(s-t)} ds$ , where the marginal product:  $\partial y / \partial k$  is a function of the relative price,  $p_s / p^*$  since  $y = y_{ns} + y_s(p_s / p^*)$ . Defining household per capita investment as a positive function,  $\Phi$  of Tobin's  $q$  gives the well known result that investment is determined by the net present value of future marginal products:  $\dot{k} = \Phi \left[ \int_t^\infty (\alpha \partial y / \partial k) e^{-r(s-t)} ds \right]$ . However, what is new here is the inclusion of the effects of the relative price,  $p_s / p^*$  indirectly via the marginal product and directly via the production function. An increase in the minimum support price,  $p_s$  will therefore lead to an increase in rural household production.

The utility maximising per capita household consumption can be easily derived from the budget constraint:  $c = \alpha y - \dot{k}$  where the optimum accumulation of capital is given by:  $\dot{k} = \Phi(\partial y / \partial k)$ . Per capita consumption is an inverse function of the maximum issue price,  $p_i$ , so that a reduction in  $p_i / p^*$  will allow the household to increase per capita consumption. This effect will be direct via the public distribution of foodgrain, denoted by  $c_i$ . However, the consequent increase in the budget constraint may also allow an increase in consumption purchases from the open market,  $c_{ni}$ . These relationships are detailed by the partial derivative::  $\partial c / \partial p_i = \partial c_{ni} / \partial p_i + (\partial c_i / \partial p_i)(p_i / p^*) + c_i / p^* < 0$ .

The final link to be made is the inverse relationship between per capita household consumption and the proportion of rural poor,  $\pi$ . This can be formalised by relationship:  $\pi = \varphi(c)$  for a suitably defined function  $\varphi$ , where  $\partial \pi / \partial c < 0$ . That is, an increase in consumption will reduce the rural poverty ratio. Since  $\partial c / \partial p_i < 0$  then  $\partial \pi / \partial p_i = (\partial \pi / \partial c)(\partial c / \partial p_i) > 0$  so that a reduction in the



maximum issue price  $p_i/p^*$  will cause a reduction in the proportion of rural poor,  $\pi$ .

To summarise, this simple growth model has three simple but important characteristics.

- C1. An increase in the minimum producer support price is expected to cause an increase rural per capita investment and production,  $\partial y / \partial p_s > 0$ .
- C2. A reduction in the public distribution maximum issue price will increase per capita consumption and reduce the proportion of rural population below the poverty line,  $\partial \pi / \partial p_i > 0$ .
- C3. Whilst poverty reducing simultaneous increases in the producer support prices and reductions in the consumer issue price are possible in the short run, the government budget constraint:  $p_i/p^* = (g - \tau)/c_i + (y_s/c_i)(p_s/p^*)$  restricts the prices to move in the same direction in the longer term.

These important characteristic relationships, C1 to C3, will now be tested.

### 3. Tests for Stationarity

The time series that will be used to test these characteristics include the minimum producer support price for wheat,  $p_s^w = p_s/p^*$  and the consumer maximum issue price for wheat,  $p_i^w = p_i/p^*$ . The producer support and consumer issue prices for rice are similarly denoted  $p_s^r$  and  $p_i^r$ . Whilst there are also support prices for coarse grains maize, barley, pulses and at least another ten agricultural commodities, rice and wheat are the most important. Paddy rice has the largest value of production of all agricultural output, whilst wheat is ranked third (behind buffalo milk). India is also ranked as the second largest producer (by international commodity value) in paddy rice and wheat (*vide* Mullen *et. al* (2005)). The estimates will indicate whether it is sufficient to use the prices for only two major cereals. Agricultural output will be measured in the form of

foodgrain production in millions of tons. This is adjusted by the rural labour force to give production per worker,  $y$ . Public distribution of foodgrain, measured in millions of tons, is transformed to per capita terms by dividing by the rural population,  $d$ . Poverty is in the form of the well known rural head count poverty ratio,  $\pi$ .

All variables are transformed using Naperian logs, consistent with the growth model above, which allows the interpretation of estimated coefficients as elasticities. The years which the data is available range from 1951 to 2001 inclusive, providing 51 observations. The difficulty here is the need to include as large a sample as possible because of the focus on the real effects of agricultural pricing policies on foodgrain production and rural poverty in a long run growth context.

The Johansen estimation procedure, which will be conducted in the next section, is also very demanding in terms of the degrees of freedom constraint. However, as the sample length is maximised over five decades there is the correct expectation that the agricultural sector and subsequent policy will have experienced significant shifts during these times. It is therefore necessary to test the time series for structural change. The other complication relates to the time series being possibly non-stationary so that observed spurious correlation may be present over this relatively long time period. The conventional augmented Dickey-Fuller tests for stationarity of a time series is biased towards not rejecting the null hypothesis of non-stationarity when structural change is present.<sup>3</sup>

Perron's (1997) Innovational Outliner (*IO2*) and Additive Outlier (*AO*) methods are used to test for a unit root in the presence of a structural change at an unknown time of the break. The *IO2* test models the change in the level of series,  $x_t$ , as a gradual process, whilst the *AO* procedure assumes the break is abrupt, with no transitional period. The *IO2* test is based on the OLS estimation of the specification:

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<sup>3</sup> *Vide* Perron (1989).

$$x_t = \mu + \theta DU_t + \beta t + \gamma DT_t + \delta D(T_b)_t + \lambda x_{t-1} + \sum_{j=1}^{\kappa} \alpha_j \Delta x_{t-j} + \varepsilon_t$$

where the dummy variable,  $DU_t = 1$  if  $t > T_b$  and zero otherwise,  $DT_t = T_t$  if  $t > T_b$  and zero otherwise,  $D(T_b)_t = 1$  if  $t = T_b + 1$  and zero otherwise. The value  $T_b$  in the range  $1 < T_b < T$  is the unknown time of the break, which is determined through searching over the sample for the minimum Students  $t$ -statistic for  $\lambda$ . The number of lags,  $\kappa$  is determined using the  $F$ -statistic to sequentially test the significance of additional lags.<sup>4</sup> The null hypothesis of a unit root,  $I(1)$ , is conducted by testing  $\lambda = 1$ , which also implies  $\theta = 0$ .

Testing for a unit root using the  $AO$  model involves two steps with the first step determining the de-trended series,  $\tilde{x}_t$ :

$$x_t = \mu + \beta t + \gamma DT_t + \tilde{x}_t.$$

The slope is then tested for structural change by sequentially determining the minimum  $t$ -statistic for  $\lambda = 1$ :

$$\tilde{x}_t = \lambda \tilde{x}_{t-1} + \sum_{j=1}^{\kappa} \alpha_j \Delta x_{t-j} + \varepsilon_t$$

In both the  $IO2$  and  $AO$  models, the null hypothesis of a unit root,  $x_t \sim I(1)$ , is rejected if the absolute value of the minimum  $t$ -statistic is larger than the critical value.

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<sup>4</sup> This search procedure adopted has important consequences for the power of the test.

Table 1 Unit Root Test – Innovational Outlier (IO2) Model

| Variable | T <sub>b</sub> | K | $\hat{\mu}$ | $\hat{\theta}$ | $\hat{\delta}$ | $\hat{\beta}$ | $\hat{\gamma}$ | $\hat{\lambda}$ |
|----------|----------------|---|-------------|----------------|----------------|---------------|----------------|-----------------|
| $p_s^w$  | 1985           | 3 | -4.718      | -1.232         | 0.131          | -0.017        | 0.030          |                 |
|          |                |   | (-5.05)     | (-4.64)        | (1.59)         | (-4.82)       | (4.76)         | (-5.045)        |
| $p_s^r$  | 1975           | 0 | -2.301      | -0.231         | 0.080          | -0.008        | 0.011          |                 |
|          |                |   | (-4.03)     | (-2.59)        | (1.13)         | (-3.06)       | (3.18)         | (-4.025)        |
| $p_i^w$  | 1978           | 7 | 1.501       | 0.831          | -0.149         | -0.034        | -0.030         |                 |
|          |                |   | (4.00)      | (3.80)         | (-1.15)        | (-3.62)       | (-4.06)        | (-4.412)        |
| $p_i^r$  | 1991           | 2 | 0.239       | 3.267          | -0.380         | -0.010        | -0.071         |                 |
|          |                |   | (4.83)      | (4.18)         | (-3.10)        | (-4.93)       | (-4.24)        | (-7.199)***     |
| y        | 1978           | 0 | -0.430      | 0.343          | -0.186         | 0.012         | -0.011         |                 |
|          |                |   | (-4.71)     | (2.93)         | (-2.30)        | (4.14)        | (-3.18)        | (-5.178)        |
| d        | 1964           | 4 | -2.727      | 1.048          | -0.122         | 0.069         | -0.072         |                 |
|          |                |   | (-2.13)     | (2.69)         | (-0.67)        | (2.82)        | (-2.95)        | (-1.894)        |
| $\pi$    | 1971           | 6 | 5.234       | 0.849          | -0.063         | 0.006         | -0.034         |                 |
|          |                |   | (5.10)      | (5.26)         | (-1.17)        | (1.85)        | (-5.29)        | (-5.180)        |

Notes: The *t*-statistic 5% critical value for testing  $\lambda = 1$  is -5.33. \*\* represents significant at the 5% level. \*\*\* significant at the 1% level. Real minimum producer support price for wheat and rice respectively:  $p_s^w$  and  $p_s^r$ . Real consumer maximum issue price for wheat, and rice respectively:  $p_i^w$  and  $p_i^r$ . Foodgrain production/ rural labour force: *y*. Public distribution per rural population: *d*. Rural head count poverty:  $\pi$ .

The structural breaks were searched over the sub sample 1958 to 1994 and there are some similarities and differences across the IO2 and AO results. The breaks for the producer support prices for wheat are similar at 1985 (IO2) and 1989 (AO), whilst the breaks for the support price for rice are 1975 (IO2) and 1974 (AO).

The two methods agree for foodgrain production (1978) and rural head count poverty (1971). The major differences exist for the issue price of wheat, where the break is estimated to be 1978 (IO2) and 1994 (AO), and for the public distribution variable with estimated breaks at 1964 (IO2) and 1987 (AO). These differences may

represent two major breaks for each series where the methods discriminate according to the speed of the transition. It is very possible the public distribution experienced a gradual adjustment starting in 1964 and a relatively abrupt change in 1987. For example agricultural production was severely affected by a major drought in 1987.

Table 2 Unit Root Test – Additive Outlier (AO) Model

| Variable | $T_b$ | $K$ | $\hat{\mu}$ | $\hat{\beta}$ | $\hat{\gamma}$ | $\hat{\lambda}$ |
|----------|-------|-----|-------------|---------------|----------------|-----------------|
| $p_s^w$  | 1989  | 3   | -3.583      | -0.014        | 0.026          |                 |
|          |       |     | (-152.43)   | (-14.63)      | (5.88)         | (-4.738)**      |
| $p_s^r$  | 1974  | 0   | -3.998      | -0.012        | 0.017          |                 |
|          |       |     | (-151.70)   | (-7.51)       | (6.47)         | (-4.521)        |
| $p_i^w$  | 1994  | 3   | 0.409       | -0.015        | -0.046         |                 |
|          |       |     | (13.29)     | (-10.70)      | (-3.49)        | (-5.499)***     |
| $p_i^r$  | 1994  | 2   | 0.170       | -0.007        | -0.045         |                 |
|          |       |     | (4.56)      | (-4.92)       | (-3.39)        | (-6.221)***     |
| $y$      | 1978  | 0   | -0.430      | 0.012         | -0.011         |                 |
|          |       |     | (-4.71)     | (4.14)        | (-3.18)        | (-5.178)**      |
| $d$      | 1987  | 8   | -4.673      | 0.026         | -0.063         |                 |
|          |       |     | (-44.52)    | (5.70)        | (-3.75)        | (-4.450)        |
| $\pi$    | 1971  | 5   | 3.915       | 0.007         | -0.027         |                 |
|          |       |     | (106.40)    | (2.76)        | (-7.58)        | (-5.138)**      |

Notes: The  $t$ -statistic 5% critical value for testing  $\hat{\lambda} = 1$  is -4.67. \*\* represents significant at the 5% level. \*\*\* significant at the 1% level. Real minimum producer support price for wheat and rice respectively:  $p_s^w$  and  $p_s^r$ . Real consumer maximum issue price for wheat, and rice respectively:  $p_i^w$  and  $p_i^r$ . Foodgrain production/ rural labour force:  $y$ . Public distribution per rural population:  $d$ . Rural head count poverty:  $\pi$ .

Given the variety of dates where there has been possible structural change, it was decided to group them into four years; 1971 for poverty; 1978 for foodgrain production and the issue price of wheat;

1985 for the producer support price for wheat and the public distribution; and 1992 because of the observed price changes in the early 1990s.

The other main conclusion to be drawn from this analysis is that the issue price of rice is almost surely stationary whilst its supply price is likely to be non-stationary. Public distribution is non-stationary and the remaining time series are ambiguous. If there is doubt about the temporal properties of a series it is better to consider it as possibly non-stationary because the consequences of incorrect inference is less severe than assuming it is stationary. The cointegration analysis in the next section will also check if all the variables are stationary. However, given the unambiguous respective findings of stationarity and non-stationarity for the issue and support price rice it was decided to exclude both prices from further analysis.<sup>5</sup>

#### 4. Johansen Cointegration

The findings from the preceding section show it is essential for the estimation procedure be appropriate for the non-stationary characteristics of the time series variables. It is also very important that the empirical estimation is based on a simultaneous equation specification given the dynamic growth model of Section 2, which detailed the complicated interdependencies. Johansen's simultaneous vector autoregressive (VAR) approach is therefore appropriate.<sup>6</sup> Define the VAR for the vector of endogenous variables,  $x_t$ :

$$x_t = \mu + \beta t + \sum_{j=1}^K \Phi_j x_{t-j} + \Psi z_t + \varepsilon_t, \quad t = 1, 2, \dots, n$$

<sup>5</sup> Given that the correlation coefficient between the wheat and rice producer support price is 0.64 and the correlation between the issue prices is 0.8, the effects of the pricing policy of rice will be indirectly included in the analysis.

<sup>6</sup> *Vide* Johansen (1991, 1995), Johansen and Juselius (1990) and Pesaran and Pesaran (1997).

where vector  $z_t$  includes the deterministic  $I(0)$  variables and dummy variables.

The optimum lag length  $\kappa$  of the VAR is determined within the possible range of one to four lags. The Schwarz Bayesian criterion (SBC) shows the optimum lag is of order one whilst the Akaike Information criterion (AIC) and the 5 per cent likelihood ratio test (adjusted for small sample) agree on a lag of two.

The vector error correction (VECM) is therefore:

$$\Delta x_t = \gamma + \beta t - \Pi x_{t-1} + \Gamma \Delta x_{t-1} + \Psi z_t + v_t$$

and this lag structure will allow Granger style sort run causality analysis. The  $\omega$  long run cointegrating relationships  $\beta x_t \in I(0)$  can be determined from the  $\Pi = \alpha\beta'$  matrix using full information maximum likelihood estimation. The number of cointegrating vectors is given by the rank,  $\omega$  of the  $\Pi$  matrix. The estimated model found that the public distribution variable has no effect at all on foodgrain production and rural poverty. Because of the severe degrees of freedom constraint the variable was dropped and the system re-estimated. The optimum lag remained at two and the calculated eigenvalues for the system with unrestricted intercept and restricted trend are: {0.7059, 0.4593, 0.2192, 0.000}. Whilst the five per cent likelihood ratio test based on the maximal eigenvalue indicates a rank of two, the same test based on the trace indicates a rank of three. The SBC and AIC model selection criteria are uninformative in that they maximise at the full rank, due presumably to the lack of the degrees of freedom. Given the characteristics C1, C2 and C3 identified in the model of Section 2 it was decided to accept the larger rank of three. Note that the three cointegrating vectors include the restricted trend:  $\{\beta_{0i}t + \beta_{1i}x_{1i} + \beta_{2i}x_{2i} + \beta_{3i}x_{3i} + \beta_{4i}x_{4i}\} \quad i=1,2,3$  with the four remaining variables.

The selected rank of three requires three identifying restrictions for each cointegrating vector. The first vector is exactly identified with the normalizing restriction on the foodgrain production variable,  $y$  and zero restrictions on the issue price,  $p_i^w$  and rural poverty,  $\pi$ . These restrictions are consistent with characteristic C1. The second vector is normalised on the poverty variable to derive the second characteristic, C2, with zero restrictions on the producer price,  $p_s^w$  and foodgrain production,  $y$ . The third characteristic, C3 of the budget constraint is obtained by normalising the third vector on the issue price and eliminating  $y$  and  $\pi$ . The FIML estimates of the just identified long run cointegrating vector  $\hat{\beta}'y$  are shown in Table 3 where the standard errors have been converted to  $t$ -statistics based on the assumption of asymptotic normality.

The long run elasticity estimate in cointegrating vector one is significant at the ten per cent level. A one per cent increase in the minimum real producer support price for wheat will increase real foodgrain production per rural worker by 1.34 per cent in the long run. The long run trend is positive and significant at the five per cent level. The second vector is significant at the one per cent level and shows that a one per cent decrease in the maximum real issue price of wheat will reduce the rural head count poverty ratio by 1.34 per cent in the long run. Note that the trend in the poverty ratio is small but positive and significant at the five per cent level.

The final vector represents the long run government budget constraint, where a one per cent increase in the minimum real producer support price is consistent with a 1.46 per cent increase in the real maximum issue price of wheat. This elasticity is significant at the five per cent level, although the trend is not.



Table 3. Estimated Long Run Cointegrating Vector Elasticities

|     |                                   |     |
|-----|-----------------------------------|-----|
| C1: | $y = 1.3414 p_s^w + 0.0274 t$     | CV1 |
|     | (1.73)* (2.48)**                  |     |
| C2: | $\pi = 1.3408 p_i^w + 0.0196 t$   | CV2 |
|     | (3.46)*** (2.21)**                |     |
| C3: | $p_i^w = 1.4579 p_s^w - 0.0014 t$ | CV3 |
|     | (2.07)** (0.14)                   |     |

Note: \* represents significant at the 10% level. \*\* significant at the 5% level. \*\*\* significant at the 1% level. Tests assume asymptotic normality. Real minimum producer support price for wheat:  $p_s^w$ .

Real consumer maximum issue price for wheat:  $p_i^w$ . Foodgrain production/ rural labour force:  $y$ . Rural head count poverty:  $\pi$ .

The error correction responses are estimated from the matrix  $\alpha$ , which provides the short run deviations of the variables from the long run equilibrium relationship,  $\beta'x_t$ . The results are detailed in Table 4, although the dummy variables for 1971 and 1978 are not reported because they were not at all significant. The 1985 dummy is significant at the five per cent level for the issue price and the 1992 dummy is significant at the one and ten per cent levels for the producer support price and foodgrain production, respectively. The equation for the producer support price has some serial correlation and heteroscedasticity at the ten per cent level. All of the significant error corrections are of the correct sign and demonstrate strong short run equilibrating behaviour.

The very significant and large coefficient of 0.756 for the issue price and 0.711 for the foodgrain production variables, mean that 71 to 76 per cent of any disequilibrium is eliminated within the year. The other variables have also relatively fast adjustments, with 42 per cent of disequilibrium in the support price and 44 per cent of rural poverty disequilibrium being eliminated in one year.

Table 4 Estimated Short Run Elasticities

|                | $ecm_1$   | $ecm_2$    | $ecm_3$   | $d_{85}$ | $d_{92}$  |                              |
|----------------|-----------|------------|-----------|----------|-----------|------------------------------|
| $\Delta p_s^w$ | -0.220    | -0.415     | -0.264    | 0.026    | 0.013     | $R^2 = 0.481$                |
|                | (-1.29)   | (-3.10)*** | (-1.70)*  | (0.59)   | (2.70)*** | $\rho : F_{1,35} = 4.05^*$   |
|                |           |            |           |          |           | $\sigma : F_{1,46} = 3.02^*$ |
| $\Delta p_i^w$ | -0.140    | -0.756     | 0.259     | 0.134    | 0.024     | $R^2 = 0.663$                |
|                | (-0.63)   | (-4.29)*** | (1.27)    | (2.34)** | (0.38)    | $\rho : F_{1,35} = 0.54$     |
|                |           |            |           |          |           | $\sigma : F_{1,46} = 3.40^*$ |
| $\Delta y$     | 0.711     | -0.203     | -0.451    | 0.033    | -0.097    | $R^2 = 0.465$                |
|                | (3.83)*** | (-1.40)    | (-2.67)** | (0.69)   | (-1.84)*  | $\rho : F_{1,35} = 0.92$     |
|                |           |            |           |          |           | $\sigma : F_{1,46} = 0.00$   |
| $\Delta \pi$   | -0.246    | 0.442      | 0.320     | -0.041   | -0.006    | $R^2 = 0.323$                |
|                | (-1.38)   | (3.17)***  | (1.97)*   | (-0.90)  | (-0.12)   | $\rho : F_{1,35} = 0.41$     |
|                |           |            |           |          |           | $\sigma : F_{1,46} = 0.11$   |

Note: \* represents significant at the 10% level. \*\* significant at the 5% level. \*\*\* significant at the 1% level. Real minimum producer support price for wheat:  $p_s^w$ . Real consumer maximum issue price for wheat:  $p_i^w$ . Foodgrain production/ rural labour force:  $y$ . Rural head count poverty:  $\pi$ .

Only one short run elasticity was found to be significant in the error correction mechanisms. This was for the lagged value of the change in the issue price of wheat:

$$\Delta p_i^w = -6.722 - 0.140ecm_1 - 0.756ecm_2 + 0.259ecm_3 - 1.077\Delta p_{s,-1}^w + 0.134 d_{85} + 0.025 d_{92}.$$

(-4.68)    (-0.63)    (-4.29)\*\*\* (1.27) (3.94)\*\*\* (2.34)\*\* (0.38)

The estimates shown above indicate that a one per cent increase in the producer support price Granger causes a 1.08 per cent reduction in the issue price. This is a significant finding whereby the authorities may move the prices of in opposite directions in order to reduce poverty. That is, if the authorities increase the maximum producer support price for wheat by one per cent, they will then reduce the maximum issue price of wheat by 1.08 per cent. However, remember that this can only happen in the short run because the government budgetary constraint must apply in the long run. This constraint is detailed in the third cointegrating vector, where the long run producer price elasticity of the issue price is +1.46.

## 5. Conclusions

A simple simultaneous dynamic growth model was developed which derived three testable characteristics, C1, C2 and C3:

C1. An increase in the minimum producer support price is expected to cause an increase rural per capita investment and production in the long run.

C2. A reduction in the public distribution maximum issue price will increase per capita consumption and reduce the proportion of rural population below the poverty line in the long run.

C3. The government budget constraint restricts the producer and issue prices to move in the same direction in the long run.

Perron's (1997) Innovational Outlier (IO) and Additive Outlier (AO) methods were used to test the stationarity of the variables and to determine the years where structural change occurred. The estimated structural changes were grouped into four years; 1971 for rural head count poverty; 1978 for foodgrain production per rural worker; 1985 for the minimum producer support price for wheat per CPI for agricultural workers; and 1992 for the maximum consumer issue price of wheat per CPI for agricultural workers. The tests of

stationarity are ambiguous for the additive outlier procedure which characterises change as abrupt. The gradual innovational outlier method clearly shows the variables are non-stationary.

The Johansen FIML procedure was used to estimate the system of VAR equations for the four non-stationary endogenous variables. Importantly, the estimation procedure explicitly incorporates the complications occurring from structural change at endogenously determined years. The rank of the simultaneous system is found to be three, which derives a cointegrating vector for each long run characteristic  $C1$ ,  $C2$  and  $C3$ . The efficient estimation of the just identified system derives important long run elasticities.

The estimates show that a one per cent increase in the real minimum producer support price for wheat will increase real foodgrain production per rural worker by around 1.3 per cent in the long run. Similarly, a one per cent reduction in the real consumer maximum issue price for wheat (via the public distribution system) will reduce the rural head count poverty ratio by 1.3 per cent in the long run. The government budget constraint applies in the long run whereby a one per cent increase in the minimum producer support price requires the consumer maximum issue price to increase by 1.5 per cent.

However the only significant short run elasticity found show that the producer support price inversely Granger causes the consumer issue price. It is possible to raise the producer support price by one percent and reduce consumer issue price by nearly 1.1 per cent in the next year. This therefore allows for an effective short run anti poverty price policy for the government. The properties of the simultaneous VAR show the system is stable with disequilibrium being mostly eliminated within two years.

This simple analysis confirms that price policy in India since independence has importantly promoted the production of foodgrain and contributed to the reduction in rural poverty. To the best of the author's knowledge there has been little conceptualisation and estimation of agricultural pricing policy in a dynamic time series

growth context. Most research in the aggregate has relied on quantities at the expense of relative prices. Prices are powerful policy instruments and the elasticity estimates contained here support this view.

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