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Foodgrain Surpluses, Yields and Prices in India

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Executive Summary

The main objective of the present study is to analyse some aspects of state intervention in the foodgrain market in India and to assess how it has impacted on foodgrain productivity, accumulation of stocks, wholesale and consumer prices, and exports. The analysis is based on a comprehensive data base compiled from Reserve Bank of India, Ministry of Agriculture, and Minstry of Consumer Affairs, Food and Public Distribution. The main findings are:

- growing agricultural subsidies- including food subsidies- have slowed down yields of wheat and rice by constraining public investment in agriculture. A related and plausible concern is that higher private investment-mainly in ground water exploitation- may have resulted in negative externalities for other farmers in the same village by lowering the water table.
- The Minimum Support Prices (MSPs) have had significant positive effects on wheat and rice procurement but these effects have weakened during the late 1990s, presumably as a result of removal of restrictions on domestic and international trade.
- Wheat and rice off-takes fall with higher MSPs, as the wedge between market and subsidised prices narrows down.
- Foodgrain stocks have grown as a consequence of higher MSPs but at a diminishing rate.
- The inflationary effects of hikes in the MSP are corroborated. The Wholesale Food Price Index (WFPI) is very sensitive to the MSP, and the former in turn raises the Consumer Price Index for Agricultural Labourers (CPIAL). As rural poverty varies positively with (unanticipated) increases in the CPIAL, the effects on the poor are larger than just lower food entitlements.
- The MSP independently of changes in the real effective exchange rate impacted unfavourably on foodgrain exports- especially because international food prices crashed in the 1990s. Exports were feasible only with subsidies. As a result, a vicious circle of hikes in the MSP, leading to higher food stocks, and export subsidies to reduce these stocks was created.

Briefly, state intervention in the foodgrain sector has hampered productivity growth, regional shifts in foodgrain production more conducive to sustainable agricultural growth, a more diversified pattern of agricultural growth in major foodgrain producing states, and has hurt the poor in different ways (e.g. limited expansion of employment opportunities, lower food and other entitlements).

Various options have been proposed to replace the present form of the MSP. These include freezing of the MSP at current levels with a view to phasing it out, and deploying the resources saved in improving farmer access to technical advice, credit and rural infrastructure, in order to facilitate a shift to higher value crops and agribusiness activities. More specific proposals include investment grants to induce a shift from foodgrain production to higher value crops and agribusiness; contract farming; and income support measures (e.g. a lump sum annual or seasonal payment to farmers based on crop area cultivated); and strengthening of other safety nets (e.g. national rural employment guarantee scheme). Little, however, can be said about their workability in the present context except that a package of reforms with a clear and coherent rationale may have greater acceptability across India’s political spectrum.

Foodgrain Surpluses, Yields, and Prices in India[1]

Introduction

The objective of this paper is to analyse the emergence of foodgrain surpluses in India in recent years, exceeding the buffer stock norms. In 2002, for example, the Food Corporation of India (FCI) had accumulated over 60 million tonnes of foodgrains- nearly three times the normal requirements for buffer stocks and the Public Distribution System (PDS) (Rao, 2005, World Bank, 2005).

The sharp rise in the quantity of foodgrains procured and in the stocks held by the FCI is a recent phenomenon[2]. The annual procurement for most years during the 1990s was 24 million tonnes until 1998-9, which rose to 31 and 36 million tonnes in the two subsequent years, respectively. This implies an addition of 19 million tonnes to the FCI stocks. Moreover, the off-take declined by 5 million tonnes in 2000-1. Larger procurements together with a decline in off-take accounted for 24 million tonnes of additional stocks. So, while both larger procurements and declining off-take resulted in larger stocks, the former is the more important factor.

Foodgrain procurements are the outcome of output and procurement prices. Available evidence points to a slowing down of the growth of foodgrain output in recent years. Although there was a decline in foodgrain output of 6 per cent in 2000-1, procurement increased by 5 per cent. The steep rise in procurement is thus not closely related to the growth of foodgrain output at the all-India level. However, a strong link between the concentration of foodgrain output in Haryana, Punjab and Andhra Pradesh –mainly of rice and wheat- and procurements cannot be ruled out. In Haryana and Punjab, which account for the bulk of wheat procurement, for example, the growth rate of wheat output was nearly the double of the all-India growth rate during 1998-2000.

Steep hikes in the Minimum Support Prices (MSPs) is yet another significant factor. The MSPs fixed by the government have been higher than those recommended by the Commission on Agricultultural Costs and Prices (CACP).There was, for example, a 25 per cent rise in the MSP for wheat in 1997-98 with a continuing rise in each of the subsequent years. As a result, the MSP rose by 54 per cent over the period 1997-2001. Although the MSPs for rice rose less steeply, they were higher by 34 per cent over the same period.

[1] We are grateful to Wayne Jones and Michael Ryan for the invitation to present this paper at the Global Agricultural Forum, organized by OECD, Paris, and for helpful suggestions. We are also grateful to Raghbendra Jha, Prabhu Pingali, Ganesh Thapa, Anil Deolalikar and Pasquale Scandizzo for constructive suggestions. The econometric analysis could not be performed without Raj Bhatia's computational expertise. The views expressed here are, however, our own and we take full responsibility for any deficiencies.

[2] This draws upon Rao (2005).

Finally, although the net exports of foodgrains have averaged 7 million tonnes during the last seven years, they may have contributed in a small measure to the FCI stocks, as there was a decline in the international prices of food grains.

While the stocks have accumulated through high MSPs, and foodgrain allocations to the PDS have increased, the subsidies have risen too[3]. Food subsidies, for example, rose from Rs 19.6 billion in 1981-2 to Rs 105 billion in 2001-2 (at 1993-94 prices).If all agricultural subsidies are added up, their total amount rose from Rs 59.2 billion in 1981-2 to Rs 364.2 billion in 1999-0, and the corresponding shares in GDP were up from 1.2 per cent to 3 per cent.That these subsidies were associated with reductions in public investment in agriculture is corroborated by a sharp decline in the latter until 2000-1 (from Rs 71.3 billion in 181-2 to Rs 44.2 billion in 2000-1), followed by a slight upturn in 2001-2 (Rs 52.6 billion) and a negligible reduction in 2002-3 (Rs 51.5 billion) (World Bank, 2005). That this decline in public investment is associated with a slowing down of growth of productivity in foodgrains is indisputable.[4]

The main concern of the present study is therefore to analyse some aspects of state intervention in the foodgrain market and assess how it has impacted on foodgrain productivity, accumulation of stocks, wholesale and consumer prices, and exports. This is done with the help of an econometric analysis of a comprehensive data base, compiled from Reserve Bank of India, Ministry of Agriculture and Minstry of Consumer Affairs, Food and Public Distribution. Our findings illustrate that the forms of state intervention analysed have hampered agricultural growth, regional and crop diversification, expansion of agricultural exports and hurt the poor through higher prices. It is imperative therefore to phase out the MSP and transfer the resources saved to build rural infrastructure, extend irrigation and ensure better access of farmers to agricultural support services. But feasibility of various policy options remains a major concern.

Foodgrain (Wheat and Rice) Policy

The Government of India (GOI) foodgrain policy is designed to address two objectives: (i) to ensure farmers a reasonable income through procurement and price support operations, and (ii) to ensure adequate availability of and access to foodgrains of consumers- especially the poor- at reasonable prices, through the Public Distribution System (PDS) and buffer stock operations. In pursuance of these objectives, the Food Corporation of India (FCI)- a government parastatal- was created. FCI or its designated state government agency procure paddy and wheat at the MSP. In addition, FCI obtains additional rice supplies through a "rice levy" on rice mills. This ranges from 10 per cent

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[3] Note that, while foodgrain allocation rose from 21.59 million tonnes in 1993-94 to 30.01 million tonnes in 2001-2, the share of off-take in total foodgrain allocation dropped sharply from 0.67 to 0.45. This resulted in a slight reduction in the amount of off-take over this period (World Bank, 2005).

[4] Public capital formation comprises mainly investments in major and medium irrigation schemes. Gulati and Batla (2002) broaden the coverage to investments in power. In both cases, public capital investments declined. They also show that a 10 per cent increase in public investment (including irrigation and power) results in a 2.4 per cent decline in agricultural GDP growth. Further, there is a strong complementarity between public and private investments in agriculture.

to 75 per cent of their milled rice output at a government prescribed levy rice. On average levy rice accounts for about 60 per cent of total rice procurement by the FCI. Paddy/rice and wheat stocks are then used for the PDS, buffer stocks and other welfare measures.

The GOI sets minimum support prices for 24 major crops, including paddy, wheat, maize, pulses, oilseeds. The Commission of Agricultural Costs and Prices (CACP) recommends MSPs for these crops every year. Farmers can sell their produce in the open market or to the FCI or its designated agency at the MSP.
A growing concern is the rapidly rising MSPs for rice and paddy and their fiscal burden, resulting in a lowering of public investment.

Until recently, the GOI generally adhered to the CACP recommendation of MSPs for rice and wheat. The CACP bases its recommendations on the C2 costs of production, including all expenses in cash and in kind, plus rent paid for leased land, imputed value of family labour and interest on owned capital. Since 1997-98, the MSPs have been set higher than the C2 benchmark. In 2001-2, for example, the weighted average C2 costs of 8 wheat producing states was Rs 4.83 per kg while the MSP was set at Rs 6.20 per kg. In 2002-3 GOI's attempts to freeze the MSPs were resisted by the main beneficiary states (Punjab, Haryana and Andhra Pradesh).Although the MSPs were frozen at 2001-2 levels, compensations took the form of a "drought relief bonus" of Rs 200 per tonne to the paddy MSP and of Rs 100 per tonne to the wheat MSP, overlooking the fact that these crops are largely grown in irrigated areas. As a consequence, the FCI was forced to procure more, resulting in burgeoning foodgrain stocks (World Bank, 2005).

The (direct) benefits of MSPs accrued to a few states where procurements were largest. Wheat procurement is concentrated in three states: Punjab, Haryana and Western Uttar Pradesh (accounting for 95 per cent of total wheat procurement), and of rice in in five states: Punjab, Andhra Pradesh, Haryana, Uttar Pradesh and Tamil Nadu (accounting for 85-90 per cent of total procurement). The total fiscal transfers to Punjab in 2001-2 amounted to Rs 19.8 billion, to Haryana Rs 9.4 billion and to Andhra Pradesh Rs 4.9 billion (World Bank, 2005).

What is perhaps an equally serious concern is that the benefits of the MSPs accrue mostly to larger wheat and rice farmers. Combining the 54th round of the NSS with two cost estimates for 1998, it turns out that transfers to a large rice farmer in Punjab were nearly 10 times the amount to a marginal farmer; and, to a large wheat farmer in the same state, nearly 13 times the amount transferred to a marginal farmer (World Bank, 2005)[5].

Wheat and Rice Yields

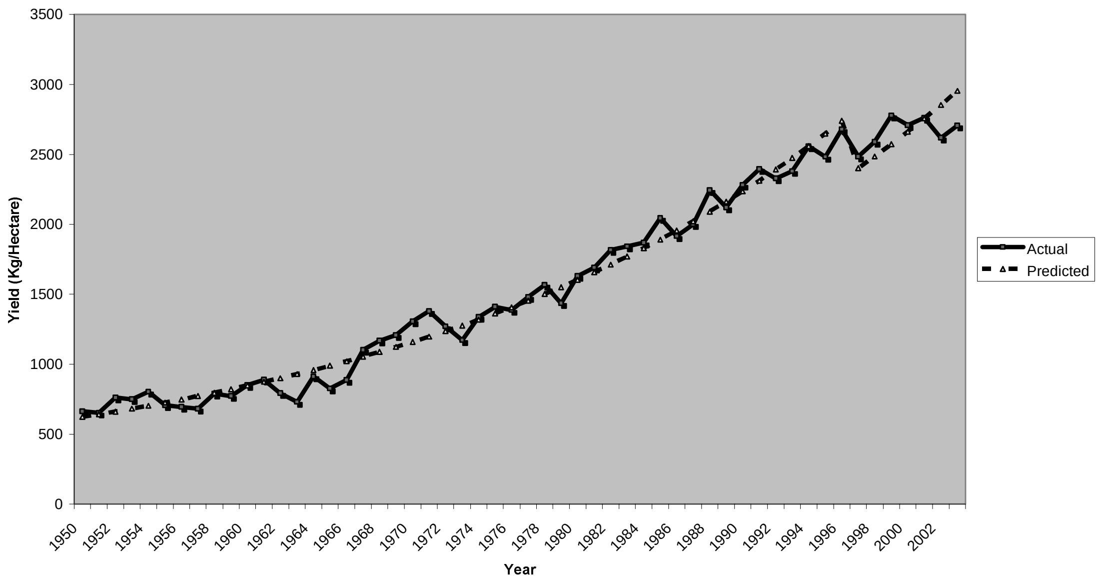
There is growing concern that foodgrain production has slowed down as a result of slowing down of public investment in agriculture. As pointed out earlier, the latter is a consequence of the mounting burden of subsidies.

[5] The cost estimates are C2 and A2+FL. The latter includes all cash costs and imputed cost of family labour. The transfers per household are twice as high with the A2+FL benchmark. Also, it is higher for wheat than for rice. For details, see World Bank (2005).

Both rice and wheat yields exhibit a positive but diminishing trend. As shown in Figures 1 and 2, 1996 on there was a marked reduction in yields per hectare- particularly of wheat[6].

In a series of econometric exercises, the following results are corroborated. In the case of wheat, productivity is positively related to fertilisers used and to public investment in irrigation. However, controlling for these effects and that of net sown area, increases in capital formation- implying essentially greater private investment in wells, tubewells-are negatively related to yields[7]. This may seem somewhat intriguing but if there are negative externalities of groundwater exploitation by individual farmers-in Haryana, for example, average water table depth falls annually by 1-33 cm-higher productivity on individual farms could be associated with lower productivity on other farms[8]. The negative relationship between wheat yields and gross capital formation is, however, robust to different specifications.

Figure 1: Wheat Yields



Similar results are obtained for rice yields. Both fertiliser and net sown area have positive effects on yields. The effect of public investment is positive too, while that of overall capital formation in agriculture is negative. The negative effect of overall capital

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[6] A quadratic time trend was fitted to logs of wheat and rice yields per hectare, with a dummy variable that takes the value 1 from 1996 on and 0 for all the earlier years. In both cases, the dummy variable has a significant negative coefficient.
[7] For details, see Table A.1 in the annex.
[8] In a recent paper based on household data collected by the National Council of Applied Economic Research, Foster and Rosenzweig (2005) show that a farmer's tubewell depth when he digs a new tubewell is deeper by 2.9 per cent if the number of wells in the village is higher by 10 per cent.

formation persists even after a dummy variable that takes the value 1 for 1996 and the subsequent years and 0 for earlier years[9].

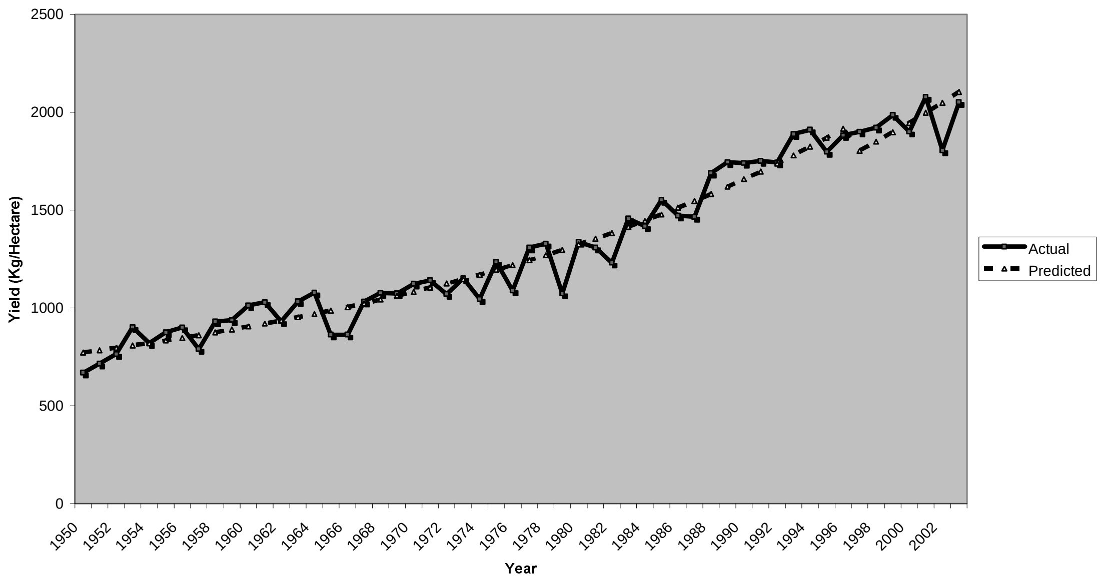
As may be noted from Figures 1 and 2, in both cases, estimated yields track actuals closely.

An important conclusion therefore is that the rapid decline in public investment in agriculture during the 1990s had a major role in explaining the fall in rice and wheat productivities not just directly but also indirectly through private investment in ground water utilisation resulting in negative externalities for other farmers in the same village.

Foodgrain Procurement, Off-Take and Stocks

Growing divergence between the MSPs for wheat and rice and their costs of production, attributable mainly to the political clout of farmers in these states, larger procurements, declining off-takes and failure to export larger values of foodgrains contributed to accumulation of foodgrain stocks, considerably in excess of buffer stock norms. Here some important results of econometric exercises are given- focusing mainly on the key role of the MSP in the accumulation of foodgrain stocks.

Figure 2: Rice Yields



Procurements of wheat and rice exhibit a positive trend with a diminishing rate. Off-take of rice also exhibits a positive trend with a diminishing rate. There is, however, a sharp reduction from 1996 on, captured by a significant negative coefficient of a dummy variable. Wheat off-take shows a positive trend except that the dummy variable has a

[9] For details, see Table A.2 in the annex.

negative but weakly significant coefficient. Not surprisingly, stocks of wheat and rice also show a positive trend but at a diminishing rate.

In order to examine the effect of the MSP on the accumulation of stocks, some additional exercises were carried out.

In the case of wheat procurement, there is a strong positive relationship with the MSP. So the higher the MSP, the greater is the wheat procurement. Controlling for this effect, the dummy variable that takes the value 1 for 1996 and the subsequent years, and 0 for the years before 1996 has a significant negative coefficient, implying a weakening of the positive effect of the MSP in more recent years[10]. Off-take of wheat is negatively related to the MSP (as the issue price rises). However, the interaction of the dummy with the MSP also has a negative coefficient, implying a stronger negative effect of higher MSPs since 1996. Controlling for these effects, there is a positive time trend[11]. Stock of wheat is positively related to the MSP, and the (predicted) wheat productivity. Controlling for these effects, the dummy variable has a negative coefficient, implying a weakening of these effects[12].

Rice procurement is positively related to the MSP, with a slight weakening of this effect since 1996. It is also positively linked to the rice output of Haryana, Punjab and Andhra Pradesh[13]. Off-take of rice is negatively related to both all-India rice output and to the output of these three states. Controlling for these effects, there is a negative effect of the MSP, and a residual positive time trend[14]. Rice stocks vary with the MSP, but less so since 1996. Controlling for the effect of the MSP, rice output of the three largest rice producing states does not have a significant effect on rice stocks[15].

How closely our specifications approximate actual wheat and rice yields is illustrated in Figures 3 and 4.

[10] For details, see Table A.3 in the annex.
[11] In an alternative specification, off-take of wheat is negatively related to (predicted) wheat productivity, and negatively to the MSP. Controlling for these effects, there is a positive time trend. For details, see Table A.4 in the annex.
[12] For details, see Table A.5 in the annex.
[13] In an alternative specification, rice procurement is positively related to all-India rice output as well as to the output of Haryana, Punjab and Andhra Pradesh. Controlling for these two effects, there is a positive effect of the MSP, which weakens since 1996. For details, see Tables A.6 and A.7 in the annex.
[14] For details, see Tables A.8 and A.9 in the annex.
[15] For details, see Table A.10 in the annex.

Figure 3 : Actual and Estimated Rice Stocks

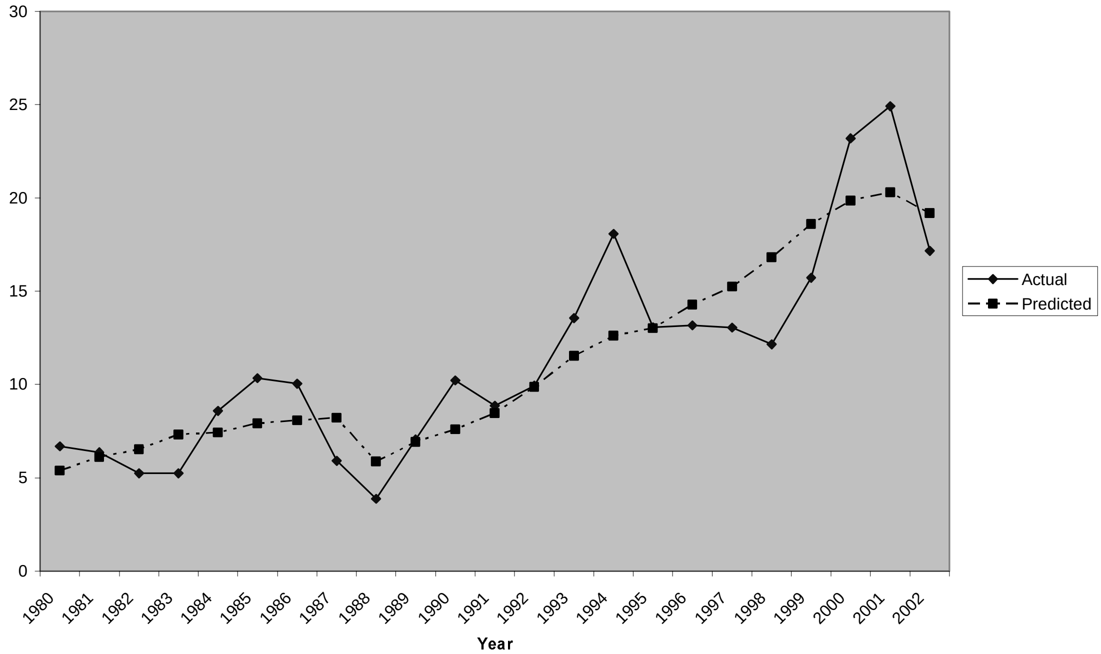
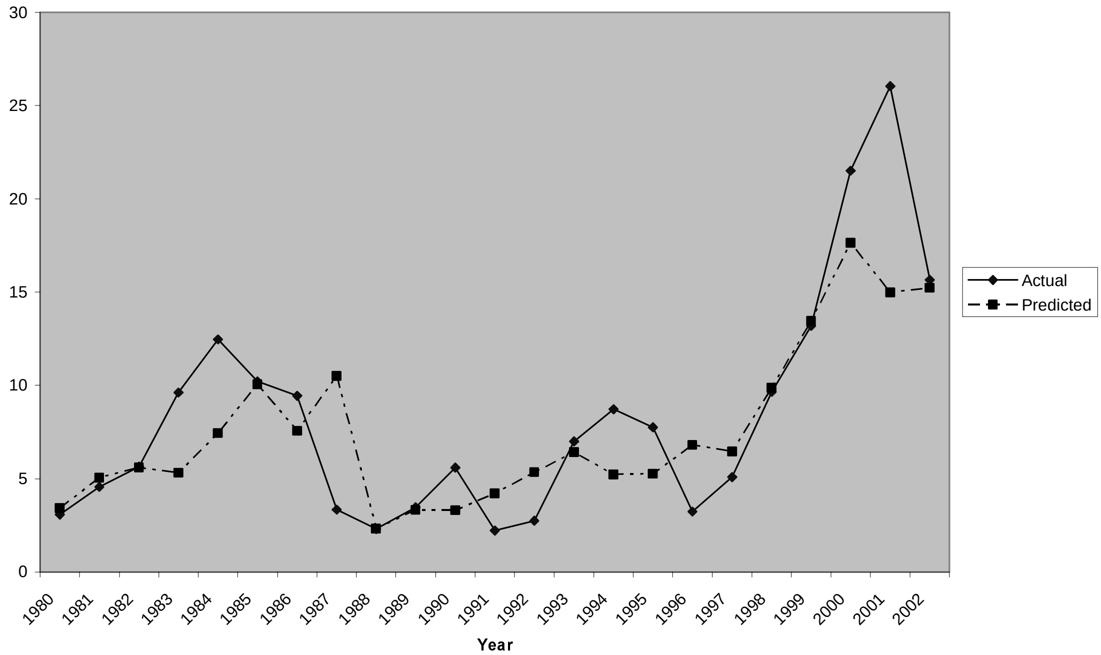


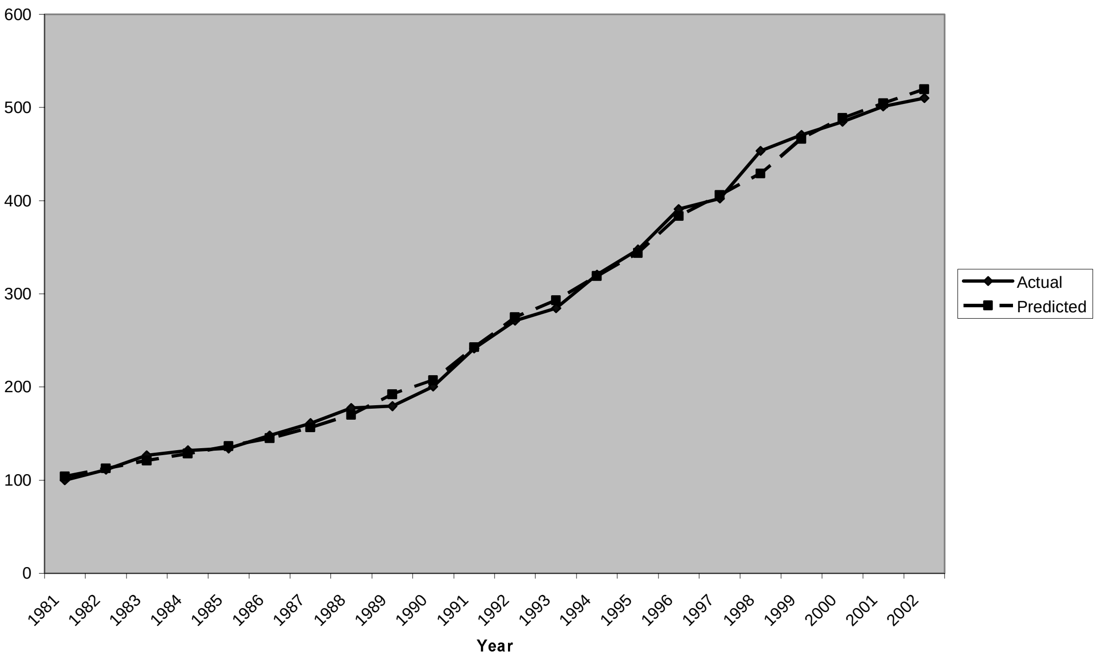
Figure 4 : Actual and Estimated Wheat Stocks



Inflationary Effects of MSP

MSP hikes have also contributed to higher wholesale and consumer prices. Unanticipated increases in the latter tend to aggravate rural poverty independently of the level of agricultural production and land inequality (Bliss, 1985, Gaiha, 1989, 1995).

Figure 5:Wholesale Food Price Indices



An econometric analysis confirms the positive effect of the (combined rice and wheat) MSP on the wholesale food price index (WFPI). Controlling for this effect, neither the gross fiscal deficit nor the money supply (M3) has a significant effect on the WFPI. There is a residual positive time trend which weakens over time[16]. That this specification tracks the actual WFPI well is illustrated in Figure 5.

The Consumer Price Index for Agricultural Labourers (CPIAL) in turn varies with the (predicted) WFPI. The former is not affected by (predicted) wheat and rice off-take. Nor is it affected by money supply (M3). There is, however, a declining residual time trend. This specification also tracks the actual CPIAL closely, as shown below in Figure 6[17].

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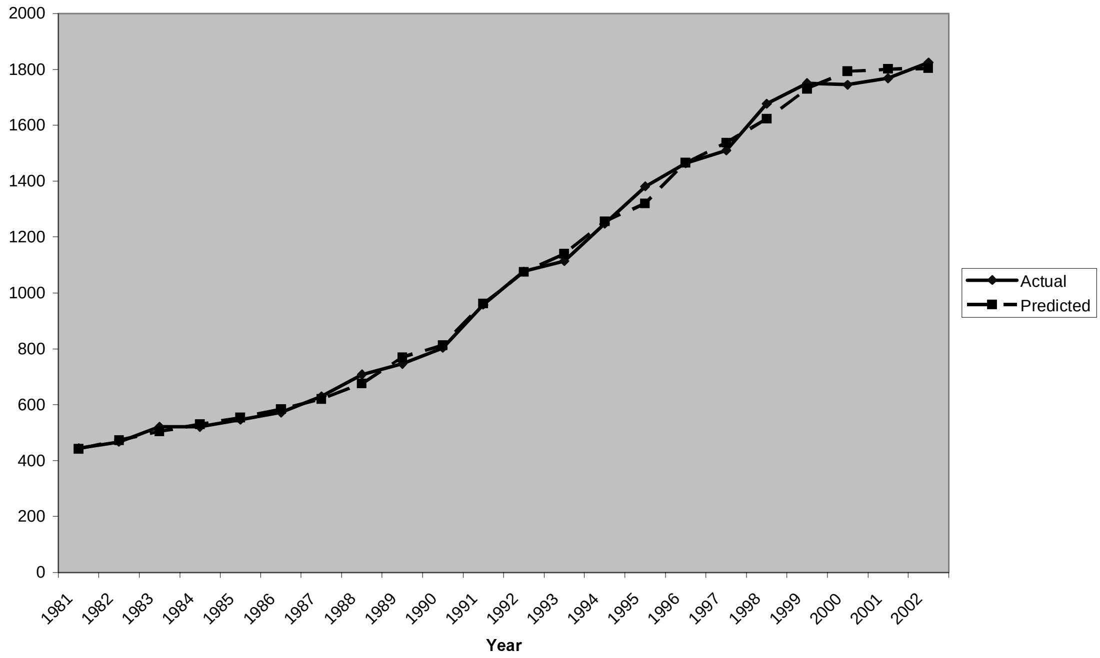
16 In alternative specifications, larger (predicted) stocks of wheat and rice) replacing the MSP have a positive effect on WFPI. For details, see Tables A.11 and A.12 in the annex.

17 For details, see Table A.13 in the annex.

Figure 6 : Consumer Price Index for Agricultural Labourers



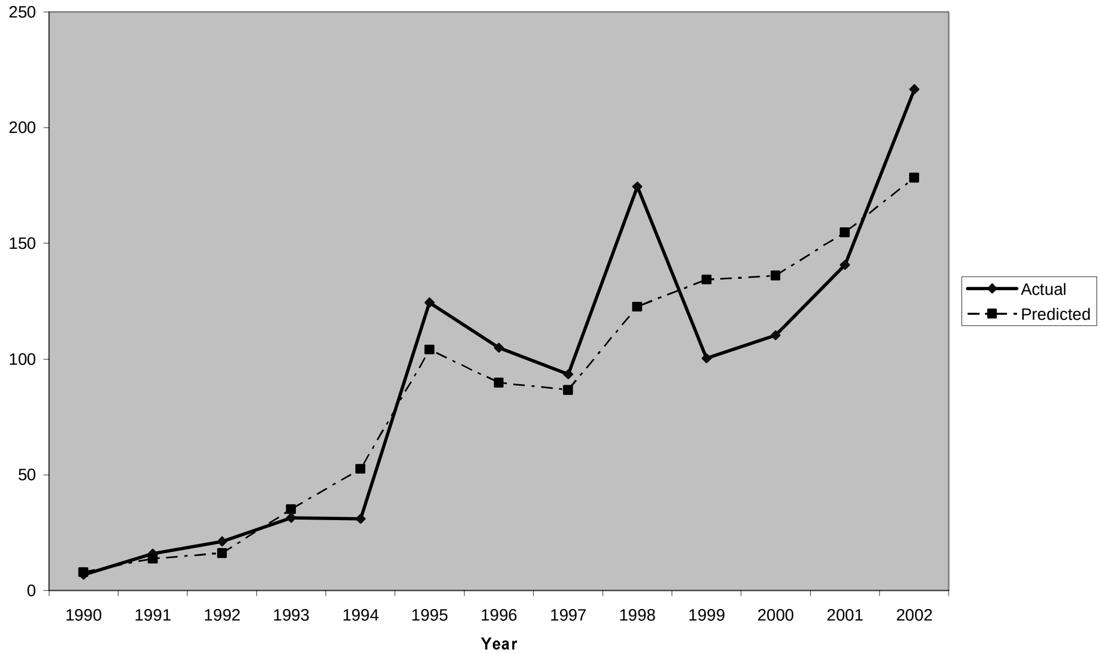
Prices, Exchange Rates and Foodgrain Exports

Not only has the state intervention in the foodgrain marketing through the MSP come in the way of greater public investment in agriculture and hurt the poor through higher prices but has also dampened expansion of foodgrain exports. Even though the share of rice and wheat exports grew from about 14.5 per cent in 1993-94 to about 19 per cent in 2003-4, with sharp fluctuations in the dollar value of wheat exports, it is arguable that a more rapid expansion was hampered by the sharp increases in WFPI, stemming from hikes in the MSP[18]. An econometric analysis corroborates this link. The MSP has a negative effect on foodgrain exports while the real effective exchange rate does not have a significant effect. There is a positive residual time trend which has weakened over time[19]. That this specification yields estimates which closely track the actual value of rice and wheat exports is illustrated below.

[18] Export subsidies for cereals were introduced in early 2000. The GOI resorted to subsidies as world cereal prices crashed in the late 1990s, coinciding with sharp hikes in the MSPs. As a result, government foodstocks rose to 60 million tones. In November 2000, the GOI decided to offer private traders wheat for export at a price equal to the Food Corporation of India's economic cost minus two years carrying cost, but not lower than the central issue price for below the poverty line households (World Bank, 2005). In 2003, the scheme was expanded to cover rice. The GOI justified its export support policy under the exemption for developing countries contained in Article 9.4 of the Agreement on Agriculture. The exports rose but so did the subsidies as well.

[19] For details, see Table A.14 in the annex.

Figure 7: Value of Foodgrain Exports



Concluding Observations

Some observations on the preceding analysis are made below from a broad policy perspective.

State intervention in foodgrain marketing in India - especially in rice and wheat- aims at protecting producers against sharp reductions in prices and ensuring adequate availability and access of low income households to foodgrains. The subsidies involved have, however, grown rapidly and contributed in large measure to fiscal stress in recent years. Moreover, the (direct) benefits of the subsidies have accrued mostly to large farmers in a few of the major wheat and rice producing states. Not only is the targeting of subsidised food through the Public Distribution System (PDS) a continuing concern, it is also far from a cost-effective way of transferring food/real income to the poor[20]. In fact, there has

[20] A not-so-recent but detailed analysis of the PDS in Andhra Pradesh, for example, shows that when both central and state expenses are accounted for, a rupee of income transferred to the poor cost Rs 6.35. If it was as dismal as this in Andhra Pradesh with a relatively efficient administration, it is likely to be much

been a sharp decline in the foodgrain off-take over the period 1993/4 -2001/02 (the ratio of off-take to allocation plummeted from 0.67 to 0.45) due to a narrowing of the wedge between subsidised and market prices. Although targeting has improved with the switch to the Targeted Public Distribution System (TPDS), a large proportion of the poorest remains excluded for various reasons (e.g. non-availability of the item in ration shops, unsatisfactory quality).

A major concern is the role of the MSP as a deterrent to the shifting of wheat and rice production to northern and eastern states, which possess highly favourable agro-ecological conditions. Existing major producers such as Haryana, Punjab and Tamil Nadu are constrained by a growing water scarcity. For a regionally more differentiated agricultural strategy that would be sustainable over the longer –term, it is vital that these states shift to a more diversified agricultural sector, growing less water-intensive and higher value crops (World Bank, 2005). Alongside, larger investments in rural infrastructure (e.g. roads, better maintenance of surface irrigation) and agricultural support services (e.g. research and extension) are a major priority.

The specific concerns raised by our analysis are:

- growing subsidies have slowed down yields of wheat and rice by constraining public investment in agriculture. A related and plausible concern is that higher private investment-mainly in ground water exploitation- may have resulted in negative externalities for other farmers in the same village by lowering the water table.
- The MSPs have had significant positive effects on wheat and rice procurement but these effects have weakened during the late 1990s, presumably as a result of removal of restrictions on domestic and international trade.
- Wheat and rice off-takes fall with higher MSPs, as the wedge between market and subsidised prices narrows down.
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- The inflationary effects of hikes in the MSP are corroborated. The Wholesale Food Price Index (WFPI) is very sensitive to the MSP, and the former in turn raises the Consumer Price Index for Agricultural Labourers (CPIAL). As rural poverty varies positively with (unanticipated) increases in the CPIAL, the effects on the poor are larger than just lower food entitlements.
- The MSP independently of changes in the real effective exchange rate impacted unfavourably on foodgrain exports- especially because international food prices crashed in the 1990s. Exports were feasible only with subsidies. So a vicious circle of hikes in the MSP, leading to higher food stocks, and export subsidies to reduce these stocks was created.

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worse in other states such as Uttar Pradesh and Bihar. For details, see Radhakrishna et al. (1997), and for a review of this and other estimates, see Gaiha (1999, 2002, 2003).

Briefly, state intervention in the foodgrain sector has hampered productivity growth, regional shifts in foodgrain production more conducive to sustainable agricultural growth, a more diversified pattern of agricultural growth in major foodgrain producing states, and has also hurt the poor in different ways (e.g. limited expansion of employment opportunities, lower food and other entitlements).

Various options have been proposed to replace the present form of the MSP (World Bank, 2005, Rao, 2005). These include freezing of the MSP at current levels with a view to phasing it out, and deploying the resources saved in improving farmer access to technical advice, credit and rural infrastructure, in order to facilitate a shift to higher value crops and agribusiness activities. More specific proposals include investment grants to induce a shift from foodgrain production to higher value crops and agribusiness; contract farming; and income support measures (e.g. a lump sum annual or seasonal payment to farmers based on crop area cultivated); and strengthening of other safety nets (e.g. national rural employment guarantee scheme). Little, however, can be said about their workability in the present context except that a package of reforms with a clear and coherent rationale may have greater acceptability across India's political spectrum.

Annex

A selection of regression results is given below.

Table A.1
Determinants of Wheat Yields Per Hectare

```
. reg ly_w  l_fert l_hyv  l_nsa l_public l_gfc

      Source |       SS       df       MS              Number of obs =      29
-------------+------------------------------           F(  5,    23) =  121.90
       Model |  1.74638616     5  .349277232           Prob > F      =  0.0000
    Residual |  .065902365    23   .00286532           R-squared     =  0.9636
-------------+------------------------------           Adj R-squared =  0.9557
       Total |  1.81228853    28   .06472459           Root MSE      =  .05353

------------------------------------------------------------------------------
        ly_w |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      l_fert |   .3970201   .0701265     5.66   0.000     .2519524    .5420878
       l_hyv |   .0318791   .1094206     0.29   0.773    -.1944746    .2582328
       l_nsa |   .0842052   .7619551     0.11   0.913    -1.492019    1.660429
    l_public |   .1867698   .1030926     1.81   0.083    -.0264934     .400033
       l_gfc |  -.3725182   .1442052    -2.58   0.017    -.6708293   -.0742071
       _cons |   7.161421   3.737476     1.92   0.068    -.5701372    14.89298
------------------------------------------------------------------------------

. dwstat

Durbin-Watson d-statistic(  6,    29) =  1.848832
```

Table A.2

Determinants of Rice Yields Per Hectare

```
    . reg ly_r  l_fert l_hyv  l_nsa l_public l_gfc

      Source |       SS       df       MS              Number of obs =      29
-------------+------------------------------           F(  5,    23) =  111.15
       Model |   1.1654518     5  .233090359           Prob > F      =  0.0000
    Residual |  .048232205    23  .002097052           R-squared     =  0.9603
-------------+------------------------------           Adj R-squared =  0.9516
       Total |    1.213684    28  .043345857           Root MSE      =  .04579

------------------------------------------------------------------------------
        ly_r |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      l_fert |   .2930058   .0599929     4.88   0.000     .1689009    .4171106
       l_hyv |    .079827   .0936089     0.85   0.403    -.1138177    .2734717
       l_nsa |    2.38765   .6518497     3.66   0.001     1.039196    3.736104
    l_public |   .2283495   .0881953     2.59   0.016     .0459037    .4107953
       l_gfc |  -.5400347    .123367    -4.38   0.000    -.7952387   -.2848307
       _cons |    -3.0007   3.197396    -0.94   0.358    -9.615018    3.613618
------------------------------------------------------------------------------

. dwstat

Durbin-Watson d-statistic(  6,    29) =  2.325756
```

Table A.3

Determinants of Wheat Procurement

```
reg lproc_w lmsp_w  d4

      Source |       SS       df       MS              Number of obs =      28
-------------+------------------------------           F(  2,    25) =   24.57
       Model |    2.786745     2   1.3933725           Prob > F      =  0.0000
    Residual |  1.41798287    25  .056719315           R-squared     =  0.6628
-------------+------------------------------           Adj R-squared =  0.6358
       Total |  4.20472787    27  .155730662           Root MSE      =  .23816

------------------------------------------------------------------------------
     lproc_w |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lmsp_w |   .7009209   .1428624     4.91   0.000     .4066902    .9951516
          d4 |  -.2856172   .1753093    -1.63   0.116    -.6466735    .0754391
       _cons |  -1.481225   .7048169    -2.10   0.046    -2.932823   -.0296279
------------------------------------------------------------------------------

. dwstat

Durbin-Watson d-statistic(  3,    28) =  1.437986
```

Table A.4

Determinants of Wheat Off-Take

```
. reg loff_w   lprod3_w lmsp_w  d4lmsp_w

      Source |       SS       df       MS              Number of obs =      23
-------------+------------------------------           F(  3,    19) =    3.00
       Model |   .68852793     3   .22950931           Prob > F      =  0.0564
    Residual |   1.4551925    19  .076589079           R-squared     =  0.3212
-------------+------------------------------           Adj R-squared =  0.2140
       Total |  2.14372043    22  .097441838           Root MSE      =  .27675

------------------------------------------------------------------------------
      loff_w |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    lprod3_w |   .9138937   .8355909     1.09   0.288    -.8350181    2.662806
      lmsp_w |   .1971471   .3152599     0.63   0.539    -.4626995    .8569936
    d4lmsp_w |  -.0629836   .0452608    -1.39   0.180    -.1577155    .0317484
       _cons |   -7.55594   6.867828    -1.10   0.285    -21.93047    6.818589
------------------------------------------------------------------------------

. dwstat

Durbin-Watson d-statistic(  4,    23) =  1.162095
```

Table A.4

Determinants of Wheat Off-Take (Alternative Specification)

```
. reg loff_w P2y_w lmsp_w lprod3r_w   t

      Source |       SS       df       MS              Number of obs =      19
-------------+------------------------------           F(  4,    14) =    4.52
       Model |  .486438766     4  .121609691           Prob > F      =  0.0149
    Residual |  .376605238    14  .026900374           R-squared     =  0.5636
-------------+------------------------------           Adj R-squared =  0.4390
       Total |  .863044004    18  .047946889           Root MSE      =  .16401

------------------------------------------------------------------------------
      loff_w |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       P2y_w |   -4.04519   1.406203    -2.88   0.012    -7.061196   -1.029183
      lmsp_w |  -1.588698   .5230233    -3.04   0.009    -2.710471   -.4669246
   lprod3r_w |   .6718056   1.103084     0.61   0.552    -1.694073    3.037685
           t |   .2543796   .0704038     3.61   0.003     .1033786    .4053807
       _cons |   34.51119   10.85437     3.18   0.007     11.23087     57.7915
------------------------------------------------------------------------------

. dwstat

Durbin-Watson d-statistic(  5,    19) =  2.388369
```

Table A.5

Determinants of Wheat Stocks

```
. reg lstock_w lmsp_w lpr_w d4

      Source |       SS       df       MS              Number of obs =      23
-------------+------------------------------           F(  3,    19) =    8.97
       Model |  6.40240644     3  2.13413548           Prob > F      =  0.0007
    Residual |  4.52222986    19  .238012098           R-squared     =  0.5861
-------------+------------------------------           Adj R-squared =  0.5207
       Total |  10.9246363    22  .496574378           Root MSE      =  .48786

------------------------------------------------------------------------------
    lstock_w |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lmsp_w |   1.039498   .3788939     2.74   0.013     .2464635    1.832532
       lpr_w |   .3983334   .1948882     2.04   0.055    -.0095723     .806239
          d4 |  -1.578808   .3773457    -4.18   0.001    -2.368602   -.7890145
       _cons |  -18.16106   6.347327    -2.86   0.010    -31.44617   -4.875951
------------------------------------------------------------------------------

. dwstat

Durbin-Watson d-statistic(  4,    23) =  1.820195
```

Table A.6

Determinants of Rice Procurement

```
. reg lproc_r   lprod3_r lmsp_r  d4lmsp_r

      Source |       SS       df       MS              Number of obs =      23
-------------+------------------------------           F(  3,    19) =   29.34
       Model |  2.38132124     3  .793773747           Prob > F      =  0.0000
    Residual |   .51399224    19  .027052223           R-squared     =  0.8225
-------------+------------------------------           Adj R-squared =  0.7944
       Total |  2.89531348    22  .131605158           Root MSE      =  .16448

------------------------------------------------------------------------------
     lproc_r |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    lprod3_r |   1.119585   .5027261     2.23   0.038      .067367    2.171803
      lmsp_r |   .3777641   .1597507     2.36   0.029      .043402    .7121261
    d4lmsp_r |  -.0418761     .03027    -1.38   0.183     -.105232    .0214798
       _cons |  -10.43792   4.359485    -2.39   0.027    -19.56243   -1.313413
------------------------------------------------------------------------------

. dwstat

Durbin-Watson d-statistic(  4,    23) =  1.869441
```

Table A.7

Determinants of Rice Procurement (Alternative Specification)

```
reg loff_r lproda_r lmsp_r lprod3r_r   t

      Source |       SS       df       MS              Number of obs =      23
-------------+------------------------------           F(  4,    18) =   43.07
       Model |  1.95096133     4  .487740332           Prob > F      =  0.0000
    Residual |  .203844268    18  .011324682           R-squared     =  0.9054
-------------+------------------------------           Adj R-squared =  0.8844
       Total |   2.1548056    22  .097945709           Root MSE      =  .10642

------------------------------------------------------------------------------
      loff_r |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    lproda_r |  -1.476232   .2943581    -5.02   0.000    -2.094656   -.8578089
      lmsp_r |  -.6052373   .2874419    -2.11   0.050     -1.20913   -.0013443
   lprod3r_r |  -.7297286   .4206878    -1.73   0.100    -1.613561    .1541036
           t |   .1278471   .0241974     5.28   0.000     .0770102     .178684
       _cons |    21.5815    3.87392     5.57   0.000     13.44269     29.7203
------------------------------------------------------------------------------

. dwstat

Durbin-Watson d-statistic(  5,    23) =  2.637188
```

Table A.8

Determinants of Rice Off-Take

```
. reg loff_r lproda_r lmsp_r lprod3r_r   t

      Source |       SS       df       MS              Number of obs =      23
-------------+------------------------------           F(  4,    18) =   43.07
       Model |  1.95096133     4  .487740332           Prob > F      =  0.0000
    Residual |  .203844268    18  .011324682           R-squared     =  0.9054
-------------+------------------------------           Adj R-squared =  0.8844
       Total |   2.1548056    22  .097945709           Root MSE      =  .10642

------------------------------------------------------------------------------
      loff_r |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    lproda_r |  -1.476232   .2943581    -5.02   0.000    -2.094656   -.8578089
      lmsp_r |  -.6052373   .2874419    -2.11   0.050     -1.20913   -.0013443
   lprod3r_r |  -.7297286   .4206878    -1.73   0.100    -1.613561    .1541036
           t |   .1278471   .0241974     5.28   0.000     .0770102     .178684
       _cons |    21.5815    3.87392     5.57   0.000     13.44269     29.7203
------------------------------------------------------------------------------

. dwstat

Durbin-Watson d-statistic(  5,    23) =  2.637188
```

Table A.9

Determinants of Rice Off-Take (Alternative Specification)

```
. reg loff_r P2y_r lmsp_r lprod3r_r   t

      Source |       SS       df       MS              Number of obs =      19
-------------+------------------------------           F(  4,    14) =   22.02
       Model |  .707481656     4  .176870414           Prob > F      =  0.0000
    Residual |  .112431688    14  .008030835           R-squared     =  0.8629
-------------+------------------------------           Adj R-squared =  0.8237
       Total |  .819913344    18  .045550741           Root MSE      =  .08961

------------------------------------------------------------------------------
      loff_r |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       P2y_r |  -1.157741   .4072725    -2.84   0.013    -2.031253    -.284228
      lmsp_r |  -.4933795   .2667903    -1.85   0.086    -1.065588    .0788287
   lprod3r_r |   .5915443   .3905002     1.51   0.152    -.2459953    1.429084
           t |   .1003732   .0267153     3.76   0.002     .0430747    .1576717
       _cons |   9.475442   3.387652     2.80   0.014      2.20965    16.74123
------------------------------------------------------------------------------

. dwstat

Durbin-Watson d-statistic(  5,    19) =  2.293985
```

Table A.10

Determinants of Rice Stocks

```
. reg lstock_r   lprod3_r lmsp_r  d4lmsp_r

      Source |       SS       df       MS              Number of obs =      23
-------------+------------------------------           F(  3,    19) =   23.38
       Model |  4.14854474     3  1.38284825           Prob > F      =  0.0000
    Residual |  1.12396884    19  .059156255           R-squared     =  0.7868
-------------+------------------------------           Adj R-squared =  0.7532
       Total |  5.27251357    22  .239659708           Root MSE      =  .24322

------------------------------------------------------------------------------
    lstock_r |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    lprod3_r |   .2648605   .7434133     0.36   0.726    -1.291121    1.820842
      lmsp_r |   1.058798   .2362336     4.48   0.000     .5643558    1.553241
   d4lmsp_r |  -.0908384   .0447622    -2.03   0.057    -.1845268      .00285
       _cons |  -5.720489    6.44665    -0.89   0.386    -19.21348    7.772504
------------------------------------------------------------------------------

. dwstat

Durbin-Watson d-statistic(  4,    23) =  1.305523
```

Table A.11

Determinants of Wholesale Food Price Index

```
reg  lwfpi lmsp   t t_sq lgdp

      Source |       SS       df       MS              Number of obs =      22
-------------+------------------------------           F(  4,    17) = 1443.01
       Model |   6.2775142     4  1.56937855           Prob > F      =  0.0000
    Residual |  .018488713    17  .001087571           R-squared     =  0.9971
-------------+------------------------------           Adj R-squared =  0.9964
       Total |  6.29600291    21  .299809662           Root MSE      =  .03298

------------------------------------------------------------------------------
       lwfpi |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lmsp |   .4897218   .1202888     4.07   0.001     .2359346     .743509
           t |   .0823942   .0130857     6.30   0.000     .0547858    .1100025
        t_sq |  -.0008895   .0002037    -4.37   0.000    -.0013193   -.0004598
        lgdp |  -.0840261   .0690123    -1.22   0.240    -.2296292    .0615771
       _cons |   1.199785   .6444351     1.86   0.080    -.1598544    2.559424
------------------------------------------------------------------------------

. dwstat

Durbin-Watson d-statistic(  5,    22) =  1.681609
```

Table A.12

Determinants of Wholesale Food Price Index (Alternative Specification)

```
reg  lwfpi lp_s  lm3 lproda_a

      Source |       SS       df       MS              Number of obs =      22
-------------+------------------------------           F(  3,    18) =   77.17
       Model |  5.84178508     3  1.94726169           Prob > F      =  0.0000
    Residual |  .454217834    18  .025234324           R-squared     =  0.9279
-------------+------------------------------           Adj R-squared =  0.9158
       Total |  6.29600291    21  .299809662           Root MSE      =  .15885

------------------------------------------------------------------------------
       lwfpi |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lp_s |   .3329648   .1586939     2.10   0.050    -.0004388    .6663684
         lm3 |   .5571351   .4527399     1.23   0.234    -.3940361    1.508306
    lproda_a |   2.487168   .2954819     8.42   0.000     1.866384    3.107953
       _cons |  -26.11191   3.375016    -7.74   0.000    -33.20256   -19.02127
```

```
dwstat

Durbin-Watson d-statistic(  4,    22) =   1.75667
```

Table A.13

Determinants of Consumer Price Index for Agricultural Labourers (CPIAL)

```
reg lcpil p_lwfpi t t_sq lp_o lm3v

      Source |       SS       df       MS              Number of obs =      22
-------------+------------------------------           F(  5,    16) = 1550.34
       Model |  5.23677061     5  1.04735412           Prob > F      =  0.0000
    Residual |  .010809061    16  .000675566           R-squared     =  0.9979
-------------+------------------------------           Adj R-squared =  0.9973
       Total |  5.24757967    21  .249884746           Root MSE      =  .02599

------------------------------------------------------------------------------
       lcpil |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     p_lwfpi |   1.183712   .1300023     9.11   0.000     .9081196    1.459305
           t |  -.0990314   .0721378    -1.37   0.189    -.2519568    .0538939
        t_sq |   .0001382   .0002324     0.59   0.560    -.0003545     .000631
        lp_o |  -.0460181   .1001097    -0.46   0.652    -.2582411    .1662049
        lm3v |   .4468396   .4400847     1.02   0.325    -.4860982    1.379777
       _cons |  -3.046769   3.796471    -0.80   0.434    -11.09493     5.00139
------------------------------------------------------------------------------

. dwstat

Durbin-Watson d-statistic(  6,    22) =  2.245881
```

Table A.14

Determinants of Foodgrain Exports (Nominal Value)

```
reg lexport  lmsp lreer t t_sq

      Source |       SS       df       MS              Number of obs =      13
-------------+------------------------------           F(  4,     8) =   33.20
       Model |  12.8545073     4  3.21362683           Prob > F      =  0.0000
    Residual |  .774379858     8  .096797482           R-squared     =  0.9432
-------------+------------------------------           Adj R-squared =  0.9148
       Total |  13.6288872    12   1.1357406           Root MSE      =  .31112

------------------------------------------------------------------------------
     lexport |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lmsp |  -9.365794   4.624371    -2.03   0.077    -20.02961    1.298025
       lreer |   -4.03542   3.278745    -1.23   0.253    -11.59622    3.525379
           t |   4.039484   1.262311     3.20   0.013     1.128591    6.950378
        t_sq |  -.0561465   .0175522    -3.20   0.013    -.0966221   -.015671
       _cons |   16.29379   26.63452     0.61   0.558    -45.12551    77.71309
------------------------------------------------------------------------------

. dwstat

Durbin-Watson d-statistic(  5,    13) =  1.979735
```

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