University of Wollongong
Department of Economics
Working Paper Series 2000

Agricultural Growth, Employment and Poverty: Theoretical and Empirical Explorations with Indian Data (1970-1993)

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WP 00-06

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ABSTRACT

There is a rapidly growing literature on the dual concern of promoting agricultural growth and reducing the incidence of rural poverty. However the analysis of the interaction of growth and poverty is an under researched area of economic policy. This paper attempts to further analyse these dual concerns in an integrated manner.

A basic endogenous growth model is developed which explicitly includes poor households and a government that has to decide how to allocate resources to the provision of infrastructure and to the public distribution of food grains. The intertemporal maximisation clearly shows the trade-off the government is facing and the indeterminate outcome. The model derives five key relationships: an agricultural metaproduction function (which allows differing temporal and spatial technical progress), rural employment and wage functions, and relationships for the public distribution of food grains and for rural poverty.

These structural equations are estimated in a simultaneous setting for fifteen Indian states using eleven years of data for the period 1970 to 1993. Care is taken in the treatment of missing values, the non-stationarity of many of the state variables, the high level of dependencies between the variables (in the form of extreme multicollinearity and endogeneity) and the presence of structural change. We believe that insufficient care has been taken with these important complications in some studies. Robust structural form, net average elasticities and reduced form impact elasticity multipliers are derived. These estimates give valuable insights into the complicated interdependencies of the policy and endogenous variables.

Whilst our broad conclusions tend to reinforce the findings of recent studies there are major differences in our estimates and methodology, which includes the conceptualisation, analytic specification and application of appropriate estimation techniques.

Keywords: Agricultural growth, poverty, public food distribution, rural and social infrastructure, net average elasticities, impact elasticity multipliers.

AGRICULTURAL GROWTH, EMPLOYMENT AND POVERTY: THEORETICAL AND EMPIRICAL EXPLORATIONS WITH INDIAN DATA (1970-1993)

D.P. Chaudhri and E.J. Wilson [1]

There has been a confluence of concerns about globalisation through free trade, sensitivity to human dignity reflected in various human rights including the right to basic nutrition and related poverty issues at the international level during the decade of 1990's. This has created a paradigm shift in our views on meaning and objectives of economic development policies.[2] Meade (1975), advising intelligent radicals on economic policy, emphasised efficiency enhancing benefits of the "removal of all unnecessary restrictions on the operation of free competitive markets". He also stated with equal emphasis that "an intelligent radical is an egalitarian. He advocates the State to "promote equality". Dixit (1996), commenting on the issue of transaction cost of economic policy shifts, rightly emphasises the importance of rigorous conceptualisation through models and confronting these with empirical evidence for enriching the policy-making processes.

Rather sluggish and uneven growth (across states) of the agricultural sector of India and the incidence of rural poverty including their interaction, despite some notable exceptions, is a rather under researched area of economic policy.[3] This is despite the existence of extensive and rapidly growing literature dealing with aspects of these interrelated issues. IFPRI (1999), IBRD (2000b) are important recent contributions to the dual concern. This paper, as part of a larger study, deals with the subject in terms of these interrelated issues.

Rural poverty, employment and wages are causally linked to the agricultural sector growth process. The drivers of the growth process would have a direct impact on them but they would significantly influence the growth itself. India's agricultural

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1 Professorial Fellow and Senior Lecturer respectively, University of Wollongong. The authors wish to thank the ACIAR for financial support, team members (Acharya, Jha, Chand, Perera, Kumar and Zhou) for stimulation and Silvana Noveska and Linda Munoz for excellent research assistance. The usual academic caveat applies.

2 For details see our main document on Sub-Project 5 and Sen (1999), IBRD (2000a, 2000b), UNDP (2000a, 2000b), UN-IMF-OECD-IBRD (2000) on centrality of equity and poverty issues in trade and development strategies.

3 See our annotated bibliography on Agricultural Policy, Poverty, Nutrition and Employment from Rural India's perspective.

development strategy, engineered during the 1960s, had the green revolution at its core with a high degree of optimism about poverty and employment. It delivered the outcomes on the production front but at a cost.[4]

The process of economic growth has been the subject of intense debate among economists of differing schools of thought over the last two centuries.[5] The recent revival of interest in the form of the 'new economics of growth' has led to an exciting resurgence in economic theorising.[6] As a consequence, there are emerging attempts to empirically test some of these theories and these efforts are attracting the attention of policy makers.

The literature on endogenous growth incorporating the role of knowledge, trade and their spillover effects has raised methodological issues pertaining to the tracking of technical progress as both incremental and jerky. In this paper we depart from the notion of a static product function and following Hayami and Ruttan (1971, 1985) develop a metaproduction function to track smooth, uneven, jerky (and partly green revolution agricultural policy strategy driven) technical progress among different states of India for the period 197 to 1993. The purpose of this paper is to conceptually, and to a lesser extent technically, incorporate these determinants in the form of a metaproduction function which is appropriately estimated for the major states of India. Employment, public distribution of food grains, agricultural wages and poverty are endogenously incorporated in the model itself.

The paper is divided into four sections. Section I is devoted to formally modelling endogenous growth in agricultural production which includes the poor and a public distribution system. Section II deals with specification of the model and estimation procedures whilst the estimated results are presented and discussed in Section III. The final section brings out policy implications of the empirical findings.

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4 See Chand (1991), Hazell and Ramasamy (1991), IFPRI (1999), and Subramaniam (1979). Optimism on labour absorption in agriculture was, in large measure, misplaced. On this see Chaudhri (1992), among many others.

5 See Marglin (1984) and Solow (1970) for competing views. For an excellent overview of the theories see Sen (1970), particularly the introductory chapter and Abhamovitz (1989).

6 Recent interest has been rekindled by Romer (1990), Lucas (1988), Ram (1986), Barro (1990, 1991), Basalla (1988), Scott (1989) among many others. The wisdom of Adam Smith on specialisation, Marshall's on external economies and Allyn Young's on increasing returns has been combined or formalised in seminal papers by Arrow (1962), Schultz (1976), Romer (1986) and Lucas (1988).

I. The Model

The model of the agricultural sector needs to include agricultural production and employment, poverty and the public distribution system. We start with a representative rural household which selects the time path of consumption, c, to maximise intertemporal utility:

$$u(c) = \int_{t_0}^{\infty} u\left[c(t)\right] e^{-rt} dt \qquad (1)$$

where $u(c)$ is a concave instantaneous utility function with $u(0) = 0$, $u(c) > 0$ and $u'(c) < 0$.[7] The parameter r is the constant discount rate. The budget constraint for the household is:

$$\dot{k} + c = wl_n + rk + d - t \qquad (2)$$

with k representing household capital and $\dot{k} = \frac{\P k}{\P t}$ is household investment. On the net income side, w is the real wage rate for the labour, l_n, employed, rk represents the household's income return from holding capital with r the real interest rate, d is the public distribution received by the household and t is the tax paid to the authorities.[8] The government budget constraint is assumed to be: [9]

$$g + d = t \qquad (3)$$

where outlays comprise government expenditure, g and transfers, d. In order to keep the analysis tractable assume the tax rate is a constant proportion, $0 < a_t < 1$, of total

7 The prime represents differentiation with respect to the relevant explanatory variable, for example $u'(c) = \partial u(c) / \partial c$, whereas the dot above the variable represents differentiation with respect to time, $\dot{c} = \partial c / \partial t$. The time subscript will be discarded where possible to keep the notation simple.

8 It is possible to include household borrowing, $\dot{b}$, on the right hand side of the constraint with the cost of borrowing, rb, on the left-hand side. In order to ensure model stability it would become necessary to restrict borrowings, $\dot{b}$, to be less than capital formation, $\dot{k}$ in net present value terms. That is, $\int_t^{\infty} \dot{b}(t) e^{-r(s-t)} ds < \int_t^{\infty} \dot{k}(t) e^{-r(s-t)} ds$.

9 The assumption of a balanced budget at all times is to keep the analysis tractable. This approach is consistent with large budget deficit financing not being a feasible option for governments over the longer term. However it does allow the possibility of small offsetting budget deficits and surpluses over shorter periods.

household income, y (net of transfers) so that $t = a_t y$. Also assume that the public distribution, d, comprises a set proportion, $0 < a_d < 1$, of total government outlays which is equal to total tax receipts. That is:

$$d = a_d \left(a_t y \right) \tag{4}$$

so that:

$$d - t = a_d \left(a_t y \right) - a_t y = \left(a_d - 1 \right) a_t y$$

Substituting for $d - t$ in (2) and defining $a_{d-t} = \left(a_d - 1 \right) a_t$ gives:

$$\dot{k} + c = wl_n + rk + a_{d-t} y \qquad -1 < a_{d-t} < 0 \tag{5}$$

Household production, $f\left(l_n, k, l_l, g \right)$, is assumed to be function of labour, l_n, capital, k, land, l_l and government expenditure, g.[10, 11] Since production is equal to household income, which comprises wage income and the return to capital:

$$wl + rk = f\left(l_n, k, l_l, g \right) \tag{6}$$

Substituting (6) into (5) with $a = 1 + a_{d-t}$ gives the new household constraint:

$$\dot{k} + c = a\, f\left(l_n, k, l_l, g \right) \qquad 0 < a < 1 \tag{7}$$

Setting up the Hamiltonian to maximise intertemporal utility defined in (1) with respect to (7) gives:

$$H = u\left(c \right) e^{-rt} + x\dot{k}$$

However it is convenient to define the costate variable, x, as the net present value of Tobin's q at the current time period, t, that is, $x = qe^{-rt}$. The Hamiltonian becomes:

$$H = u\left(c \right) e^{-rt} + q\dot{k}e^{-rt} \tag{8}$$

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10 The production function is assumed to be well behaved: $x(0) = x_0$, $f_x' > 0$, $f_x'' < 0$, $\lim_{x \to 0^+} f_x' = \infty$ and $\lim_{x \to \infty} f_x' = 0$ where $f_x' = \partial f / \partial x$, $f_x'' = \partial^2 f / \partial x^2$, $\forall x \in \{ l_n, k, l_l, g \}$.

11 Government expenditure could be separated into government consumption and investment expenditures. The effects of government investment on household production could therefore be included by assuming that government investment is a constant proportion of total government expenditure. In order to capture externalities and keep the analysis simple, the Barro notion of including total government expenditures will be used here.

and the costate equation $\dot{x} = -H_k$ gives the important result:

$$\dot{q} = rq - \left[a\ f_k'(l_n, k, l_l, g)\right] \tag{9}$$

which derives the solution for q:[12]

$$q = \int_t^{\infty} \left[a\ f_k'(l_n, k, l_l, g)\right] e^{-r(s-t)} ds \tag{10}$$

Equation (10) clearly shows that Tobin's q is the sum of the net present value of all future marginal products of capital. In steady state, $q = 1$ and $\dot{q} = 0$, which when substituted in equation (9) gives the standard result, $f_k' = r$. Since q represents the marginal valuation of capital then higher values of q will encourage investment according to the investment function, $\dot{k} = \Phi(q)$ with $\Phi' > 0$. Substituting for q using (10) gives:

$$\dot{k} = \Phi\left\{\int_t^{\infty} \left[a\ f_k'(l_n, k, l_l, g)\right] e^{-r(s-t)} ds\right\} \tag{11}$$

The relationship for the marginal product of labour is obtained by solving the Hamiltonian first order condition to derive $f_{l_n}' = w$. The two equivalent forms for labour and capital are:

$$f_k' = r, \quad f_{l_n}' = w \tag{12}$$

The growth in consumption can also be determined by substituting out the costate variable to give the well known result:

$$\frac{\dot{c}}{c} = q\left[a\ f_k'(l, k, g) - r\right] \tag{13}$$

where $\frac{-1}{q} = \frac{cu''(c)}{u'(c)}$ is the elasticity of marginal utility with respect to consumption. Inspection of equation (13) shows that the growth in consumption is inversely related with the rate of time preference, r, whilst it is also a positive function of the marginal product of capital, f_k'. Clearly, increases in productivity increase the

12 The notation f_k' denotes the partial derivative with respect to capital, $\partial f / \partial k$.

growth rate of capital via equations (10) and (11) and therefore the growth rate in household consumption.

In order to analyse the equilibrium path, rearrange the household budget constraint in equation (5) to $c = -\dot{k} + wl + rk + a_{d-t} y$ and integrate from time, t_0 to infinity. This gives:

$$\int_{t_0}^{\infty} c(t) e^{\int_t^{\infty} r(s)ds} dt = -k_{\infty} + \int_{t_0}^{\infty} w(t) l_n(t) e^{\int_t^{\infty} r(s)ds} dt + k_{t_0} e^{\int_t^{\infty} r(s)ds} + a_{d-t} \int_{t_0}^{\infty} y(t) e^{\int_t^{\infty} r(s)ds} dt \tag{14}$$

Discounting to time, t_0, by multiplying both sides by $e^{-\int_{t_0}^{\infty} r(s)ds}$:

$$\int_{t_0}^{\infty} c(t) e^{-\int_{t_0}^{t} r(s)ds} dt = h(t_0) + k(t_0) + a_{d-t} y(t_0) \tag{15}$$

where $h(t_0) = \int_{t_0}^{\infty} w(t) l_n(t) e^{-\int_{t_0}^{t} r(s)ds} dt$ and $y(t_0) = \int_{t_0}^{\infty} y(t) e^{-\int_{t_0}^{t} r(s)ds} dt$. Equation (15) shows the present value of consumption at time t_0 is a function of total household wealth, which comprises the sum of the net present values of human capital, $h(t_0)$ and non-human capital, $k(t_0)$, net of the present value of government transfers and taxation, $a_{d-t} y(t_0)$.

Now in order to determine the level of consumption at time t_0, integrate the relationship (13) forward to obtain:

$$c(t) = c(t_0) e^{\int_{t_0}^{t} q[a f_k'(s) - r] ds} \tag{16}$$

Using (16) to substitute out $c(t)$ in (15) gives:

$$c(t_0) \int_{t_0}^{\infty} e^{\int_{t_0}^{t} \{q[a f_k'(s) - r] - r(s)\} ds} dt = h(t_0) + k(t_0) + a_{d-t} y(t_0)$$

$$\therefore c(t_0) = p\left[h(t_0) + k(t_0) + a_{d-t} y(t_0)\right] \tag{17}$$

with $p = \left\{ \int_{t_0}^{\infty} e^{\int_{t_0}^{t} \{q[a f_k'(s) - r] - r(s)\} ds} dt \right\}^{-1}$. Inspection of (17) shows the level of consumption at time t_0, denoted $c(t_0)$, is also a function of household wealth. Note the positive relationship between government transfers and household consumption at time t_0. An increase in transfers will increase current consumption by a factor of $p a_{d-t}$.

However, there will be negative effects of this increase in transfers on consumption over time. For a given taxation regime, $0 < a_t < 1$, the proportion of government expenditure, g, must fall. This will reduce the marginal productivity of capital. Note that $g = t - d$ so that the proportional output relation:

$$g = (1 - a_d) a_t y = a_g y \qquad 0 < a_g < 1 \tag{18}$$

shows that an increase in a_d means that a_g must fall for a given level of a_t. Now consider the general production function:

$$y = A l_n^{d_1} k^{d_2} l_l^{d_3} g^{d_4} \tag{19}$$

Substituting (18) into the production function (19) gives:

$$\begin{aligned} y &= A a_g^{d_4} l_n^{d_1} k^{d_2} l_l^{d_3} y^{d_4} \\ \therefore y &= B a_g^{b_0} l_n^{b_1} k^{b_2} l_l^{b_3} \end{aligned} \tag{20}$$

where $B = A^{\frac{1}{1-d_4}}$, $b_0 = \frac{d_4}{1-d_4}$, $b_i = \frac{d_i}{1-d_4}$, $\forall i = 1,2,3$. The marginal product of labour associated with this production function determines employment:

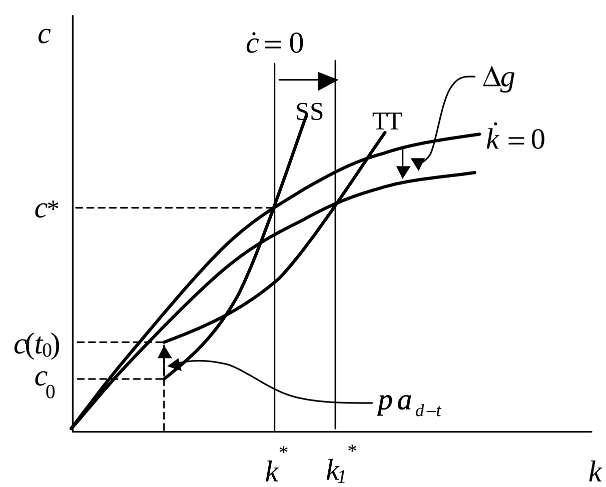
$$l_n = f_{l_n}' = B a_g^{b_0} b_1 l_n^{b_1 - 1} k^{b_2} l_l^{b_3} \tag{21}$$

Now consider an increase in public distribution, which causes government expenditure to fall. This is shown by a reduction in $a_g^{b_0}$ in (20) above, which will cause the production function to rotate down. The marginal product of capital defined as:

$$f_k' = B a_g^{b_0} b_2 l_n^{b_1} k^{b_2 - 1} l_l^{b_3} \tag{22}$$

will also fall. Importantly this will reduce the growth rate of consumption given in equation (13). Schematically, the increase in the public distribution shifts the household from old saddlepath, SS to new saddlepath, TT in Figure 1. There is an increase in initial consumption shown in (17) by pa_{d-t} . Consumption increases from c_0 to $c\left(t_0\right)$ on the new saddlepath.

Figure 1



However, the new long run steady state will also change. The decrease in government expenditure will rotate the $\dot{k}=0$ locus, shown in (11), downwards. The steady state consumption locus, $\dot{c}=0$ defined in equation (13) will shift to the right, consistent with a higher stock of capital, *k*, needed to increase the relatively lower marginal product of capital $f_k^{'}$ to be equal to the unchanged rate of time preference, r . This may lead to a new steady state with higher or lower consumption. The figure shows a similar level to the old steady state value of c^*. However, it is important to note that the dynamic adjustment along the new saddlepath, TT, will be slower than for the original saddlepath, SS. So even if the new steady state level of consumption is higher, the increase in consumption will be slower from the higher initial starting point.

To summarise, an increase in public distribution will have complicated effects on rural consumption for a given tax regime. The additional resources flowing to agricultural households will allow an initial increase in consumption. However the diversion of resources away from the provision of public infrastructure will reduce marginal productivity and therefore the growth rate in consumption over time with possibly higher or lower steady state consumption. This poses a real dilemma for a government which has little scope for deficit financing and a relatively underdeveloped tax system. The authorities, whilst knowing that public distribution to the agricultural poor will slow growth, may have little option if the level of poverty is high and widespread.

These possible reinforcing and opposing effects of the public distribution system on the agricultural sector will be tested in the next section. The system of equations comprise the identified important agricultural relationships:

Production:	$y = Al_n^{d_1} k^{d_2} l_l^{d_3} g^{d_4}$	(19)
Employment:	$l_n = f'_{l_n} = Ba_g^{b_0} b_1 l_n^{b_1 - 1} k^{b_2} l_l^{b_3}$	(21)
Public Distribution:	$d = (a_d a_t) Al_n^{d_1} k^{d_2} l_l^{d_3} g^{d_4}$	(4), (19)
Wages:	$w = f'_{l_n}$	(12)
Poverty	$p = y(c_0) = y\left[p\left(h_0 + k_0 + a_{d-t} y_0\right)\right], \quad y' < 0,\ c_0 < c_{min}$	(17)

II. Model Specification and Estimation

The variables to be used for the estimation of the five key agricultural relationships are listed below with their relevant details. All variables are in Naperian logs:

Table 1
Details of Variables

Variable	Name	Unit of Measurement	Symbol	Class
State agricultural domestic product	*SDPA*	Constant 1980-81 prices, Rs	y	Endogenous
Agricultural employment [13]	*AGEMP*	Numbers employed, 000's	l_n	Endogenous
Public distribution of total food grains [14]	*PDGTG*	Tonnes, 000's	d	Endogenous
Rural wage rate [15]	*RWAGE*	Const. 1960-61 prices, Rs	w	Endogenous
Rural head-count poverty	*RHCP*	Proportion of rural poor to total rural population, %	p	Endogenous
Electrification	*ELEC*	Proportion of villages electrified, %	g, (k)	Exogenous
Cropped area irrigated	*IRRIG*	Proportion of cropped area irrigated, %	g, (k)	Exogenous
Net sown area	*NAS*	Hectares, 000's	l_l	Exogenous
Rural road density	*ROAD*	Kms per 000 square kms	g	Exogenous
Development expenditure	*DEVEX*	Const. 1960-61 prices, Rs	g	Exogenous
Rural literacy	*LIT*	Proportion of rural population that is literate, %	h	Exogenous
Rural population	*RPOP*	Numbers, 000's	n	Exogenous

13 The figures were interpolated for the years 1970, 73, 86, 89, 90 and 92. Punjab figures were used for Himachal Pradesh.

14 Total food grain distribution from the central and state governments.

15 Punjab rural wage rates were also used for Himachal Pradesh.

We have data for fifteen Indian states, which are listed in alphabetical order in Table 2:

Table 2
Major Indian States

Andrha Pradesh Bihar	Karnataka Kerala	Punjab Rajasthan
Gujarat	Madhya Pradesh	Tamil Nadu
Haryana	Maharashtra	Uttah Pradesh
Himachal Pradesh	Orissa	West Bengal

The data for these variables and states are available for eleven years: 1970, 72, 73, 77, 83, 86, 87, 89, 90, 92 and 1993. The data trends and descriptive statistics are summarised in Tables 3, 4 and 5. Unfortunately there are thirteen missing years during this period, nine in the first half of the sample and four in the second half. The study by IFPRI (1999) interpolate the important variables (like rural head count poverty) with simple exponential averaging between the available years. This increases the sample size from eleven to twenty four consecutive observations and allows for dynamic analysis in the form of simple distributed lagged specifications. The additional benefit of interpolation is that it smoothes the data and therefore improves the regression's ability to track the data. This procedure is common and can also be found in the World Bank (2000) study. However we believe that there were too many missing values to meaningfully interpolate, particularly for the missing periods 1974 to 1976 and 1978 to 1982 inclusive, which comprise three and five year spans respectively. Whilst more observations would certainly be desirable, interpolation effectively means that 54% of the data sample would be synthetically derived. The dynamic analysis of IFPRI (1999) and the study by World Bank (2000) therefore use inappropriate research methodology, which may provide misleading results and questionable policy recommendations.

There is a general misconception that researchers should attempt, with whatever means, to maximise the number of observations and therefore the degrees of freedom in their estimation procedures. It is more important that the selection of the span of the data is appropriate for the intended analysis. That is, the sample size is more relevant than the number of observations. The period 1970 to 1993 is sufficiently long to be appropriate for our analysis and we make the important decision to use only the available data. This decision is important because it restricts this paper to cross-sectional analysis and rules out the possibility of an explicit treatment of dynamics. However the degrees of freedom is not a problem here because we have data for fifteen states and eleven time periods, for each of the twelve variables.

This availability of data is suitable for a pooled cross-section time series econometric estimation procedure. However analysis of the time series properties for each variable for each state indicates the widespread existence of non-stationarity. The results of the augmented Dickey-Fuller (ADF) tests of the Naperian logged variables, obtained from the Microfit econometric software package, are reported in Table 6. Whilst this test has very low power for such small samples, it is included here for demonstration purposes. Having said this there appear to be many instances where the null hypothesis of the existence of a unit root cannot be rejected at the 5% level of significance. These occurrences number 114 out of a possible 180, which represents 63 percent of the total. Only 37 percent of the entries, shown in bold in Table 6, reject the null hypothesis at the 5% level.[16] There also appears to be a high degree of intertemporal heterogeneity in the variables, indicated by a range of optimum lags for the ADF regression according to the Schwarz Bayesian criterion (SBC) shown in parentheses, and the sensitivity to the inclusion of a deterministic time trend.

Importantly, the variables for all-India, obtained by stacking the eleven observations for each of the fifteen states to give 165 observations for each variable, are mostly stationary at the 5% level of significance. The two exceptions are the Naperian logs of agricultural employment (*AGEMP*) and rural population (*RPOP*). This is a pleasing result because it allows us to stack the data for regression analysis, which also substantially increase our degrees of freedom. Secondly it allows valid statistical inference of the coefficients estimated from the stacked variables.

These indications highlight a dilemma discussed in Chaudhri and Wilson (1997). Pooled Kmenta type estimation, which typically partitions the diagonal elements of the pooled regression variance-covariance matrix into fifteen diagonal blocks (one for each state), allows correction for heteroscedasticity. However, this procedure will derive asymptotically biased estimates of the standard errors. This is due to the possibility of the non-stationarity in the variables when partitioned into the eleven observations for each of the fifteen states. The alternative is to run the regression using all the 165 observations for each variable without the correction for heteroscedasticity. It is argued that the presence of heteroscedasticity, which reduces statistical efficiency and derives larger standard errors of the parameter estimates, is preferred to the presence of non-stationarity. This latter problem causes the standard error estimates to be biased in unknown ways and therefore does not allow valid statistical inference of the parameter estimates. The ultimate test of the adopted procedure is to see whether the inefficient parameter estimates are statistically significant. If this is the case then the loss in statistical efficiency is not a problem.

A related issue is the inclusion of state specific dummy variables to determine state specific effects on the parameter estimates. Given the desire to determine the differences in the parameter estimates across states, the inclusion of slope dummy variables is equivalent to the pooling procedure. As argued above, this approach is undesirable in the presence of non-stationarity of the variables in many of the states. In order to have confidence in the parameter estimates it is necessary to deliberately exclude some state specific information. This is best done by only including state intercept dummy variables, which give the required degree of under-identification of the state effects. To see this consider the generalised regression function for the stacked variables where each state, designated by i, $i = 1,\ldots.,p$, has $j = 1,\ldots.,m$ observations:

$$\tilde{y}_t = C^* \prod_{r=2}^{s} \tilde{X}_{rt}^{g_r} \, e_t \qquad t = 1,\ldots,n = mp \tag{23}$$

The column vector $\tilde{X}_r$ includes both exogenous and endogenous variables for $r = 2,\ldots.,s$. Now set $\tilde{X}_{rij} = C_{ri}\tilde{x}_{rij}$ and $C^* = D_i C_1$ where C_{ri} incorporate the specific state environment slopes for each of the variables, $r = 2,\ldots.,s$ and D_i includes the state intercept effects. Substituting gives for state i:

[16] *Vide* Perron (1989) who shows that unit root tests are biased away from the alternative hypothesis of I(0) if a structural break is present in the series.

$$\tilde{y}_{ij} = D_i C_1 \prod_{r=2}^{s} \left(C_{ri} \tilde{x}_{rij} \right)^{g_r} e_{ij} \qquad (24)$$

which clearly shows the state effects in terms of levels, C_i and slopes, D_{ri} for $r = 2, \ldots, s$. Taking Naperian logs of equation (24) gives:

$$ln\ \tilde{y}_{ij} = \left(ln\ D_i + \sum_{r=2}^{s} g_r\ lnC_{ri} \right) + lnC_1 + \sum_{r=2}^{s} g_r\ ln\tilde{x}_{rij} + ln e_{ij} \qquad (25)$$

which has the standard dummy variable representation in unrestricted form:

$$y_{ij} = w_i + j + \sum_{r=2}^{s} g_r x_{rij} + u_{ij} \qquad (26)$$

The state dummy variable $w_i = 1$ for state i and 0 otherwise, and in order to avoid the dummy variable trap, we limit i = 2, ..., p. [17] The constant term, j, represents the selected benchmark state of Punjab.

This specification limits the state specific effects to the intercept and purposely omits the slope effects in order to exclude the non-stationary problems of inference of the estimates of $\hat{g}_r$, $r = 1, \ldots, s$. The intended under-identification of the specification is in order to be able to make unbiased statistical inference of the parameter estimates.

The preliminary Shazam econometric results showed evidence of extreme multicollinearity in the Naperian logged variables with high adjusted coefficients of determination, $\bar{R}^2$, and *t*-statistics, which were very sensitive to the specification of the included variables in the regressions. The condition numbers were typically much greater than the benchmark level of thirty.[18] Table 7 clearly shows the large number of linear explanatory variable dependencies for each of the five equations. Each entry in the Tables 7a to 7e show the $\bar{R}^2$ for a linear regression of the dependent variable against all the explanatory variables in each of the five equations. For the state domestic product ($SDPA$) equation in Table 7a, 80% of all state $\bar{R}^2$'s are above 0.8 with nine being singular and 22 of the 90 entries having value of 0.99. The adjusted coefficients of determination for the remaining four equations, agricultural

[17] Lau and Yotopoulos (1989) give a similar demonstration of representation (26) in terms of "efficiency factors".

employment (*AGEMP*), public distribution of total food grains (*PDGTG*), rural wages (*RWAGE*) and rural head count poverty (*RHCP*) whilst lower, are still very high.

The Tables 7a to 7e also show the $\bar{R}^2$'s for the all-India stacked variables are above 0.8, with only *PDTG* in the *RHCP* equation and the *RWAGE* in the *AGEMP* equation being the two exceptions. Accordingly it was necessary to use the principal components (PC's) estimation procedure for all of the five equations.

The final complication in the estimation was to allow for the high degree of endogeneity in the endogenous variables as specified in the model equations (4), (12), (17), (19) and (21). Since dynamic analysis was excluded because of the missing values there was not the option of using predetermined, lagged endogenous variables as instruments. The notes to Table 8 list the selected, assumed exogenous, instrumental variables for each of the endogenous variables. The adjusted coefficient of determination for each regression of the endogenous variable against the selected instruments is also shown in the first part of Table 8. Consider the state domestic product (*SDPA*) equation which includes the endogenous variable agricultural employment (*AGEMP*) as an explanatory variable. The table shows the adjusted coefficient of determination for the instruments for agricultural employment is 0.99. [19] This shows that the instruments are valid and there will be minimal loss in statistical efficiency. The rural head count poverty (*RHCP*) equation includes *SDPA*, *AGEMP* and the public distribution of total food grains (*PDTG*) as endogenous explanatory variables. The adjusted coefficients of determination for the instruments of these variables are 0.83, 0.99 and 0.74 respectively, which again indicate they are worthwhile instruments. It can be seen that the only exception is the use of the four instruments to replace the rural wage (*RWAGE*) endogenous variable in the agricultural employment equation. They do not track this variable particularly well as indicated by the relatively low adjusted coefficient of determination of 0.50.

Given our interest in comparing the post and pre-liberalisation periods we tested for structural change in each of the five equations over the sample period to 1993. The results of the CUSUM squared tests for each of the five equations, estimated for each state, are shown in Table 9. Whilst these tests have low power for small samples there are a number of structural changes identified at the 10% level of

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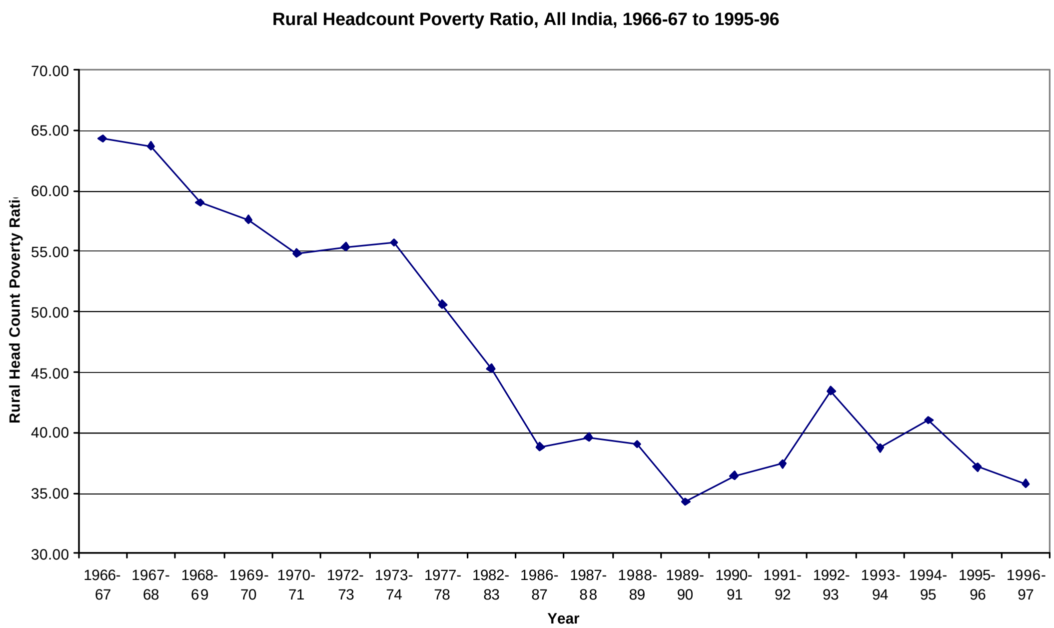
18 *Vide* Judge *et.al.* (1985), p. 903 for an explanation of this method.

19 That is, the regression of agricultural employment against its six instruments has an adjusted coefficient of determination of 0.99.

significance. These changes occurred at different times for different equations for different states. The rural wage equation exhibited the most occurrences with breaks in nine states, mostly in the late 1980's.[20] The states of Bihar, Rajasthan and Tamil Nadu had marginally more breaks than most of the other states, with Karnataka, Kerala and Madhya Pradesh not demonstrating any significant changes in the five equations.

Figure 2



The identified structural breaks can be grouped into three broad periods, early 1980's, late 1980's and early 1990's. The second period coincides with the drought of 1987 and the emerging foreign exchange problems which forced the economic reforms in the early 1990's. Preliminary analysis by Chaudhri and Wilson identify changes to the structure of poverty in the rural sector as occurring in 1988 and 1993 using all-India data for the period 1966-67 to 1995-96.[21] Inspection of the time series of rural head count poverty ratio, shown in Figure 2, shows the possible reversal of trends around 1988 and 1993. Whilst our interest is in the changes since liberalisation in 1991 our data sample ends in 1993 and so there are not enough data points to compare the effects of events since 1991. We therefore select 1989 as the change point and re-estimate the five equations allowing for structural change in the slope

[20] This agrees with our difficulty in finding suitable instruments for this variable.

[21] The details of these sequential Chow tests are reproduced in Tables A2 and A3 in the Appendix.

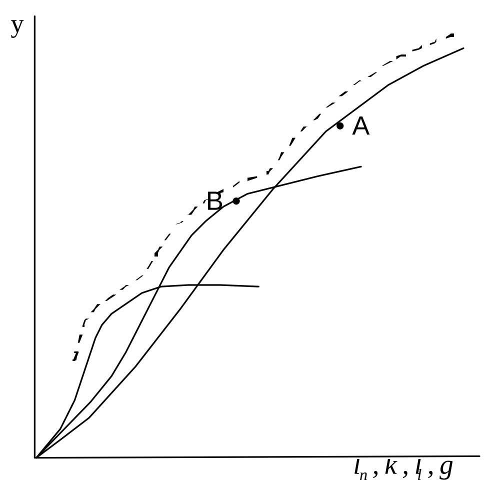
coefficients over the final four data points.[22] The specification (26) is adjusted to accommodate this:

$$y_{ij} = w_i + j + \sum_{r=2}^{s} \left(g_r x_{rij} + l_n f_r x_{rij} \right) + u_{ij} \qquad (27)$$

with $l_n = 1$ for $j = 1989,....,1993$ and zero otherwise. The estimate of $\hat{f}_r$ for $r = 1,....,s$ represents the change to the full sample parameters, $\hat{g}_r$, due to the structural change. The *t*-values will indicate whether the structural change coefficient, $\hat{f}_r$, is significantly different from the $\hat{g}_r$ estimate.[23]

Like Chaudhri and Wilson (1995, 1997) we will refer to the representation (27) of the production function (19) as a metaproduction function after Hyami and Ruttan (1970, 1985). The optimising production decisions, encapsulated in the equations in the model, ensure that production will always be on a maximum envelope characterised by (27), which explicitly includes state differences and differences in the post-liberalisation period, 1989 to 1993. One possible envelope, by way of example, is shown in Figure 3. Clearly state agricultural production may be on different parts of this envelope.

Figure 3



[22] There are four observations for each of the 15 states which gives 60 observations. The problem of non-stationarity, explained earlier, should not be a problem. because the short sub-sample has only four data points, 1989, 90, 92 and 1993.

[23] The year 1977 also appears exceptional and an additional intercept dummy variable will be included taking unit value in this year and zero elsewhere.

Importantly the metaproduction function allows a state, whose agricultural sector is relatively highly placed on the envelope say at or near point A in Figure 3, may have a higher marginal product than a state producing at point B. This also applies to a particular state where the effects on production vary from the pre to post-liberalisation period.

III. Econometric Results

The regression results for the estimation of the five equations using instrumental variables and principal components are recorded in Table 10. The coefficient estimates are elasticities because of the double-log representation of (27) used to specify these equations. We will call these estimates 'net average elasticities'. The description of 'net' is used to acknowledge the endogenous interdependencies between the variables and 'average' because the measured responsiveness of the two variables is an average over the sample period.

Various specifications and different combinations of variables were estimated for each equation. However it was found that the parameter estimates varied little with the instrumental variables and principal components procedures.[24] Similarly, changing the structural change break period from 1989 to 1987 only changed some estimated coefficients by around 10%. The lack of sensitivity of the parameter estimates to these specification changes is reassuring because it strongly indicates that these estimates are robust. However it is important to understand that the principal components procedure is crucial to this conclusion. Because of the very high degrees of interdependencies between the variables, the estimates are very sensitive to these changes in specification. Indeed, any result can be obtained when principal components are not used. This observation calls into doubt many studies which have not used this correction procedure.

[24] The criterion adopted for the selection of the number of principal components for each regression was based on the number of stochastic explanatory variables included in the regression. Typically the eigenvalues reduced and then plateaued, as expected, for the fifteen state dummy variables which are orthogonal to each other but not to the earlier derived eigenvalues. It was decided not to include all of these eigenvalues because the degrees of freedom constraint often outweighed the gains from including them all. So the rule of thumb adopted was to select the number of eigenvalues equal to the number of non-dummy explanatory variables in the regression.

Table 10a shows the net average elasticities for the agricultural production function. All variables are significant for the full sample 1970 to 1993 at the 1% level of significance, with the exception of the road (*ROAD*) proxy for the government provision of agricultural infrastructure. Net area sown (*NAS*) and the proportion of cropped area irrigated (*IRRIG*) have the largest elasticities of 0.54 and 0.32 respectively. Agricultural employment (*AGEMP*) and the proportion of villages electrified (*ELEC*) whilst smaller, are similar in size at 0.17 and significant. Interestingly the coefficients for these explanatory variables sum to 1.20 at the 1% level of significance, indicating increasing returns to scale in agricultural state domestic production. An important component of this result is the contribution of the publicly provided infrastructure to the agricultural production process. Note also the significant effects of the structural change in the period 1989 to 1993. The elasticity of net sown area increases by around 15% whilst the elasticity of roads halved for this period.

These results are encouraging because the estimates, including most of the others reported in Tables 10b to 10e, are significant at the 1% level. They also justify the specification (27) which sacrificed statistical efficiency in the elasticity estimates. Remember the estimation procedure purposely did not use the Kmenta pooled type estimation correction for heteroscedasticity in order to avoid inadvertently introducing biases in the standard error estimates caused by the presence of non-stationary state variables. The very significant net average elasticity estimates also show the validity of the instrumental variables which were used here in an attempt to obtain statistically consistent estimates. The relatively close fits of the equations are indicated by the reported correlation coefficients between the actual and predicted values of the dependent variables.[25]

The state effect on agricultural state domestic production (*SDPA*) is positive and significant for Punjab at the 1% level. However Haryana and Kerala are significantly above that for this benchmark state, Punjab, whilst Himachal Pradesh and Karnataka are below it. The relative position of these two states further

[25] This measure was used because the distributional characteristics of summary statistics are really unknown for cross-sectional, simultaneous instrumental variables and principal components estimation procedures. The correlation coefficient is for indicative purposes only and gives an overall comparison of the original data and the conditional predictions resulting from the accumulated steps in the estimation procedures.

deteriorated relative to Punjab after liberalisation. However Kerala, Madhya Pradesh and Orissa improve their relative positions during this period.

The estimates for the second equation, which details the determinants of agricultural employment (*AGEMP*), are reported in Table 10b. The net average elasticities are large and significant. Agricultural state domestic production (*SDPA)* and rural head count poverty (*RHCP*) have the expected positive elasticities of 0.4 and 0.5 respectively. The rural wage (*RWAGE*) is inversely related to agricultural employment, with an elasticity of around -0.4, reflecting the diminishing marginal productivity of agricultural labour. The significance of the rural wage elasticity is surprising given the relatively poor performance of the instruments used for this variable in the estimation process that was reported in Table 8 and commented on in the previous section. Since liberalisation, the elasticity for *RHCP* has increased by a little over 10% and the elasticity for *RWAGE* has also increased by nearly 20%. These changes are significant at the 1% level.

Agricultural employment in Haryana, Himachal Pradesh and Kerala are below that for the significant benchmark state of Punjab, for the whole sample period. Importantly there is a further falling behind in the post-liberalisation period. In contrast, Karnataka, Madhya Pradesh, Maharashtra, Orissa and Tamil Nadu agricultural employment are above that for Punjab and these states' agricultural employment is further improving relatively since liberalisation.

Table 10c shows the estimated net average elasticities for the determinants of rural head count poverty (*RHCP*). *SDPA* and the human capital proxy of the proportion of rural population that is literate (*LIT*) have the expected negative effects, with elasticities of around 0.1. These effects increase to 0.17 and 0.14 respectively in the period 1989 to 1993. The positive elasticities for *AGEMP* and for the public distribution of food grain (*PDGTG*) reflect the increased need for further employment and government transfers in the face of increasing poverty. These elasticities are large and significant with the employment elasticity being around 0.2 and double the public distribution elasticity effect of around 0.1. However, the *PDTG* effect doubles to 0.2 in the post-liberalisation period and is therefore significant and important at the 1% level. The rural population pressure variable (*RPOP*) has an important affect on the increase in poverty, although this effect is reduced by about 20% after 1989.

These results, using disaggregated state data in a simultaneous equation setting with principal components, show the dangers of relying on aggregate single equation studies. The robust net average elasticities reported here, whilst very significant, are much smaller in magnitude than those estimated from single equation studies using aggregate data.[26]

Andhra Pradesh and Bihar have significantly higher poverty levels and the relative difference is worsening since liberalisation. Whilst Orissa also has higher poverty, the relative position is improving in the post-liberalisation period. The poverty in Uttar Pradesh is below the average and falling relatively since 1989.

The estimated net average elasticities for the determinants of the public distribution of total food grains are shown in Table 10d. Consistent with the previous equation, poverty positively affects public distribution with an elasticity close to unity, which falls by around 10% in the second period 1989 to 1993. Development expenditure (*DEVEX*) and literacy also have large positive elasticities of 0.8 and 0.5 respectively. The positive effect of literacy reflects peoples increased knowledge and understanding of the political and economic system, including individual rights, which increase their effective access to the public distribution system. The state specific characteristic of Punjab is significant and negative, implying this benchmark state has lower levels of public distribution than the average. Kerala, Orissa, Tamil Nadu and West Bengal all have higher levels of public distribution than for Punjab. This level of government involvement is increasing since post-liberalisation, with the exception of Orissa where it has reversed to a lower level than for Punjab. Haryana, Himachal Pradesh, Karnataka and Uttar Pradesh have lower levels public distribution of food grains relative to the Punjab and these levels are falling significantly since 1989.

The final Table 10e details the estimates of the net average elasticities for the rural wage (*RWAGE*) equation. As reported earlier the instruments for rural wages were not as close fitting, reflecting institutional, social and political factors being important in the determination of rural wages. This is shown in the relatively poor fit of the estimated equation with the indicative correlation coefficient between the observed and predicted values being only 0.35. Having said this, agricultural

[26] This approach, including preliminary work by the authors reported in the Appendix, generate unrealistically large elasticity estimates. The reason for this is a single equation, with aggregate data, may proxy the accumulated intertemporal and spatial system-wide causes and effects. This is excacerbated when the variables exhibit high degrees of collinearty and non-stationarity. Disaggregation and specification of more than one stationary relationship distributes these effects across relevant variables and their estimated coefficients.

employment (*AGEMP*) is inversely related to *RWAGE* with a significant elasticity of -0.3 at the 1% level. This effect is diminished by a little over 10% in the period 1989 to 1993. Note also that productivity, in the form of literacy (*LIT*) reflecting human capital and the infrastructure provision of irrigation (*IRRIG*), have a small but 1% significant effect on *RWAGE*, but only after 1989.

The wage effect for Punjab is significantly positive reflecting a higher agricultural wage rate for the state. Himachal Pradesh has higher agricultural wages whilst Maharashtra and Uttar Pradesh have lower wages than the average, at the 5% level of significance. These differences increase by around 30% to 40% during the 1989 to 1993 period.

The reduced form equations are listed in Table 11. The results for the full sample 1970 to 1993 are detailed in Table 11a whilst Table 11b also includes the specific structural change effects for the period 1989 to 1993. Both tables show the state specific intercept dummy variable effects on the five endogenous variables towards the top. The lower box reports the elasticities calculated from the reduced form which we will call 'impact elasticity multipliers'. The descriptor 'impact' is used because the elasticity describes the same period effect whilst 'multiplier' acknowledges the reduced form includes all cumulative effects amongst the endogenous variables. Net area sown (*NAS*) and the proportion of cropped area irrigated (*IRRIG*) have major impacts on *SDPA* and *AGEMP*. *NAS* has the larger effect on these variables with elasticities of 0.60 and 0.30 respectively. The elasticities for *IRRIG* are 0.35 and 0.17. These effects on *SDPA* also increase markedly during the liberalisation period, whilst their effects on *AGEMP* decrease marginally at the same time. The literacy rate (*LIT*) and development expenditure (*DEVEX*) have relatively large but opposing influences on the public distribution of food grains (*PDTG*). The effect of *LIT* is strongly positive with elasticity of 0.48 whilst *DEVEX* has a negative and smaller effect of -0.14. However, when structural change is included the *DEVEX* impact elasticity multiplier more than doubles to -0.32. Both *LIT* and *DEVEX* reduce rural poverty (*RHCP*) with respective elasticities -0.06 and -0.02 although after liberalisation *LIT* is less effective whilst the *DEVEX* elasticity increases to -0.08, similar to the values for *NAS* (-0.08) and *IRRIG* (-0.05). Rural population (*RPOP*) has an expected significant and positive elasticity effect on poverty of 0.12. *LIT* also has a positive influence on rural wages (*RWAGE*) with the elasticity increasing to 0.09 in the period 1989 to 1993.

In terms of the state effects, Andhra Pradesh, Gujarat Kerala, Maharashtra, Orissa, Tamil Nadu and West Bengal all have greater than average public distribution of food grains. However this effect is lessened when structural change is allowed after 1989. Whilst *RHCP* is higher for Bihar and Orissa this effect is lessened after liberalisation. Finally the rural wage (*RWAGE*) is higher for Haryana and Himachal Pradesh and interestingly it increases significantly for all states after 1989.

IV. Conclusions and Policy Implications

This paper makes three contributions to the analysis of the interdependencies between economic growth and the incidence of rural poverty in the Indian agricultural sector. The first is the holistic approach which involves the conceptualisation of the interrelated issues, formal modelling of the key factors and estimation in a simultaneous setting. Each of these components in our research methodology are essential to the successful definition of the problem, formulisation of the analytic structure to be used as the basis of the analysis, and the selection of appropriate econometric techniques to derive relevant policy output.

The second contribution of this paper is the development of a basic endogenous growth model which explicitly includes poverty and the involvement of government in the agricultural sector. The role of the government is important because it decides on the proportion of taxation receipts to be allocated to the provision of government infrastructure and the public distribution of food grains to the poor. The intertemporal maximisation clearly shows the trade-offs of the government decisions on the poor, although the household's steady state welfare is indeterminate without imposing further theoretical assumptions. This model derives five key relationships: a metaproduction function, employment and wage functions and relationships for the public distribution of food grains and for poverty. These can be tested to determine the consequences of government policy on the poor.

The third contribution of our work is the econometric estimation of these relationships in a simultaneous setting which explicitly incorporates the statistical complications from using an incomplete data set for disaggregated state variables. The major problems here are the treatment of missing values, the non-stationarity of many of the data series, the high level of interdependencies between the variables (in the form of extreme multicollinearity and endogeneity) and the presence of structural change. A number of more recent studies do not pay adequate attention to these severe problems, which implies their results are flawed and their policy recommendations based on these findings are therefore questionable. This study, by contrast, argues that interpolation of the missing values is inappropriate and that the estimation procedure needs to take account of the non-stationarity that is present in the data. The treatment of extreme collinearity is also crucial because of the sensitivity of the estimates to the specification. Inadequate conceptualisation and formal modelling of the economic structure allows the *ad-hoc* specification of relationships, which seriously affect the conditional parameter estimates. The specification of the simultaneous model and the treatment of endogeneity are also important, particularly allowing for structural change in the late 1980's. Whilst the modelling and simultaneity issue have been considered by other studies, the other important points raised here have not.

The research methodology adopted in this paper derives robust net average elasticities for the five endogenous variables, state output (*SDPA*), agricultural employment (*AGEMP*), rural head count poverty (*RHCP*), public distribution of food grains (*PDTG*) and rural wage (*RWAGE*). The robust estimates of the net average elasticities for the seven policy variables are also calculated in the structural equations. These variables are net sown area (*NAS*), the proportion of villages electrified (*ELEC*), the road density in rural India (*ROAD*), the proportion of cropped area irrigated (*IRRIG*), rural population (*RPOP*), the proportion of literate rural population (*LIT*) and development expenditure (*DEVEX*).

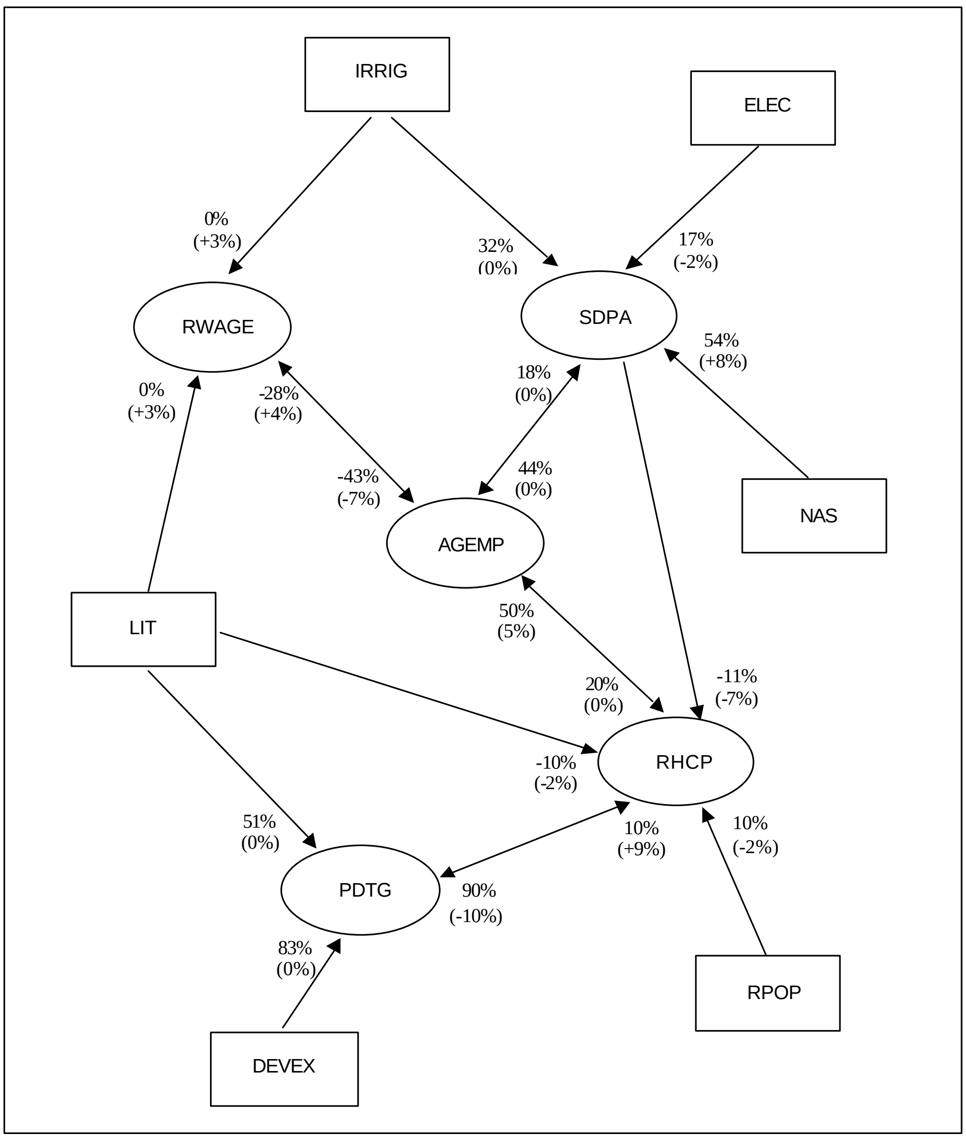
These effects are summarised in Figure 4 with the endogenous variables circled and the policy variables enclosed in rectangles. The arrows indicate the detected causation from explanatory variable to dependent variable in the structural relationships. The percentages denote the net average elasticities which are significant at the 1% level.[27] The first elasticity is the estimate for the entire sample 1970 to 1993 and the elasticity in parentheses represents the percentage point change to that elasticity in the period 1989 to 1993.

The estimates (detailed in Table 10) show the important interdependencies of the endogenous variables in the structural equations. For example, output and wages affect employment; employment affects output, wages and poverty; output,

[27] If the elasticity estimate is not significant at the 1% level then it is shown as 0% in Figure 4.

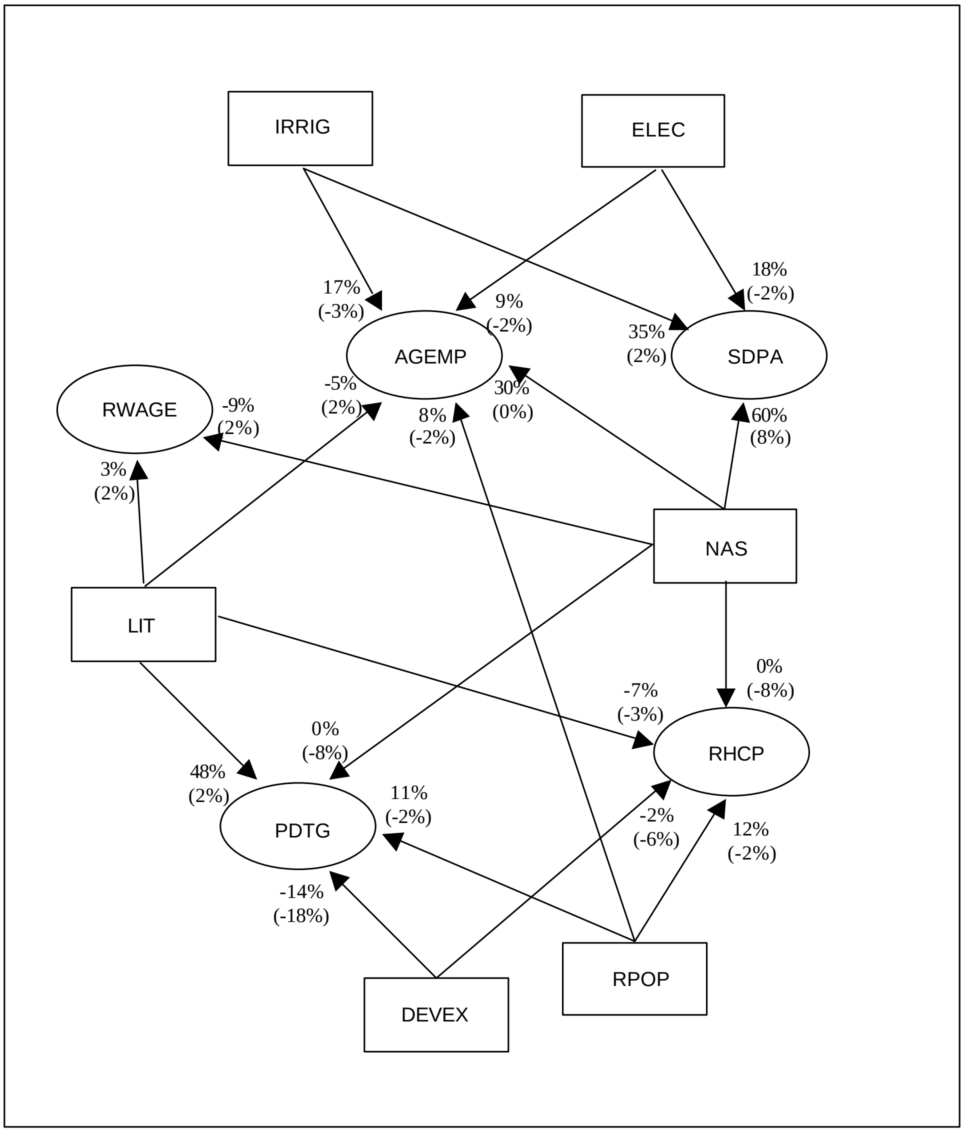
employment and public distribution affect poverty; and poverty affects public distribution. The estimates of the net average elasticities for the policy variables also show the significant effects (also at the 1% level) of publicly provided infrastructure in the form of *ELEC* and *IRRIG*, as well as *NAS*, to agricultural production, employment and wages. These variables were also found to be important determinants of rural poverty (*RHCP*). Other important determinants of poverty are the public distribution of food grains (*PDTG*), literacy (*LIT*) and rural population (*RPOP*). The determinants of *PDTG* are in turn, development expenditure (*DEVEX*) and literacy (*LIT*).

Figure 4
Estimated Structural Relationships



The policy variables effects on the endogenous variables are calculated in terms of reduced form impact elasticity multipliers. These elasticities (detailed in Table 11) trace through and accumulate the effects of the policy variables via the interdependencies in the endogenous variables. The important links are summarised in Figure 5 and Table 12.[28]

Figure 5
Estimated Reduced Form



28 Because there are no estimated standard errors and therefore *t*-statistics for the reduced form, the coefficients were selected on their relative absolute sizes. Since the *ROAD* variable was not

Table 12
Estimated Reduced Form Impact Elasticity Multipliers

	NAS	*ELEC*	*IRRIG*	*RPOP*	*LIT*	*DEVEX*
SDPA	0.60 (0.68)	0.18 (0.16)	0.35 (0.37)			
AGEMP	0.30 (0.30)	0.09 (0.07)	0.17 (0.14)	0.08 (0.06)	-0.05 (-0.03)	-0.01 (-0.05)
RHCP	(-0.08)		(-0.05)	0.12 (0.10)	-0.07	-0.02 (-0.08)
PDTG	(-0.07)		(-0.04)	0.11 (0.09)	0.48 (0.50)	-0.14 (-0.32)
RWAGE	-0.09 (-0.07)				0.03 (0.05)	

In order to summarise the important effects only the reduced form impact elasticity multipliers which total more than 5% are included in Figure 5 and Table 12. The top elasticity in each cell of Table 12 is estimated for the entire sample 1970 to 1993. The elasticities in parentheses below these have been estimated allowing for structural change in the period 1989 to 1993. The major linkages between the policy and endogenous variables can be summarised into the following points:

- There is a significant inverse relationship between development expenditure (*DEVEX*) and the public distribution of total food grains (*PDTG*). The reduced form impact elasticity multiplier is -0.14 which increases to -0.32 in the structural change period 1989 to 1993. This result quantifies the trade-off modelled in our endogenous growth model whereby the authorities have to decide on the intertemporal allocation of tax revenue between the long term provision of infrastructure and the short term public distribution of food to the poor.
- The structural form equation for *PDTG* shows the net average elasticity for the rural poor (*RHCP*) is 0.94 (which declines marginally in the later structural change period of 1989 to 1993). This implies that increases in the poor will lead to an almost equi-proportionate increase in public distribution.

significant in the structural equations it is not included here.

- The public distribution of food grains (*PDTG*) is positively affected by literacy rates, in the form of the proportion of rural population that is literate (*LIT*). The elasticity is 0.48 which increases marginally after liberalisation. We believe this reflects the increasing awareness of peoples economic and political rights which improves their access to and the demand for, publicly distributed food grains. Rural population (*RPOP*) also increases the demand for public distribution with an average elasticity of 0.10.
- Rural head count-poverty (*RHCP*) is also positively affected by *RPOP* with an elasticity of 0.12. Whilst the provision of infrastructure is not important in the full sample 1970 to 1993 it becomes significant in reducing poverty in the period reflecting structural change and agricultural sector liberalisation during 1989 to 1993. The sum of the impact elasticities for *ELEC*, *IRRIG* and *DEVEX* increase from -0.02 for the full sample to -0.14.
- The impact elasticity multipliers show that the provision of infrastructure is important for the promotion of state agricultural output (*SDPA*) and employment (*AGEMP*). The elasticities for the proportions of cropped area irrigated (*IRRIG*) and villages electrified (*ELEC*) are respectively 0.35 and 0.18 for *SDPA* and 0.17 and 0.09 for *AGEMP*. These values are consistent over the later structural change period.
- The structural and reduced forms also derive elasticities for fifteen Indian states which show the heterogeneity of the state's policy environment effects. These state specific factors appear very important and need to be included in any meaningful analysis of Indian agricultural growth and poverty.

In conclusion, we emphasise the importance of rigorous and logical conceptualisation of the relevant issues. The underlying metaphor is as important as the quantitative information base used to draw inferences. Examples of success in dealing with poverty successfully are available within India (for example Kerala through policy and Punjab through agricultural productivity growth). State level factors like institutions, governance, implementation of laws on the statute books that favour the underdogs (for example minimum wage laws implementation in Kerala) and the attitude to a development strategy that pays as much attention to growth as to equity needs serious research. All we have shown is that state specific effects are important shifters of estimated relationships.

Finally, the role of the State (Adam Smith called these the duties of the Sovereign) in providing rural physical infrastructure (roads, irrigation, electrification and social infrastructure (we used literacy as a proxy of rural education and associated support institutions) gets highlighted once again. On this, IFPRI (1999) and World Bank (2000) conclusions are reinforced by our analysis although there are major differences in our methodology and empirical estimates. However, the importance of state specific institutions and policies towards growth, poverty and public distribution strategies and policies highlighted by our results needs serious detailed examination. Within India we have examples of success and monumental failure.

India's agricultural sector growth strategy needs urgent rethinking. Whilst equity and growth separability in textbooks provides conceptual clarity, this approach is unsustainable as an exercise in Political Economy in a democratic polity.

Table 3a: Trends in Rural Poverty, Output and Public Distribution of Foodgrains in Major States of India, 1970-1993

	Rural Head Count Poverty[a] (RHCP)			Net Agricultural SDP Constant Price (80-81 Prices) (Rs. Lakh) (SDPA)			Public Distribution of Total Food Grains Per Poor Person[b] (PDGTG)			Rural Population (Actual Numbers) (RPOP)			Agricultural Employment[c] (Actual Numbers) (AGEMP)			Rural Wage Rate[d] (Rs per day in 1980/81 prices) (RWAGE)		
	1970	1983	1993	1970	1983	1993	1970	1983	1993	1970	1983	1993	1970	1983	1993	1970	1983	1993
Andhra Pradesh	48.4	26.5	16.0	289514	401782	494297	224	1287	2407	34519710	42477691	50290772	17661352	18594000	20861000	5.57	7.45	8.91
Bihar	63.0	64.4	58.0	271762	325457	308313	605	932	673	50184550	63725746	78145341	17948180	20061000	21311000	5.49	6.71	8.74
Gujarat	46.4	29.8	22.2	261349	304858	242655	253	362	668	18771870	24156727	27843311	8925817	9483000	8313000	6.32	9.78	9.43
Haryana	34.2	20.6	28.7	132726	172682	268825	115	209	91	8066227	10518255	12932451	3369739	2726000	2107000	7.70	1.84	1.70
Himachal Pradesh	34.2	20.6	28.7	21985	29354	35350	2	88	177	3034108	4096843	4892248	4215722	3479000	3098000	14.39	13.36	18.84
Karnataka	55.1	36.3	28.2	213231	275149	407151	236	655	917	21758150	27262537	32101458	11453656	11501000	11691000	5.19	5.25	5.68
Kerala	59.2	39.0	25.9	124394	118576	190354	925	1545	2036	17526356	20825942	21568908	4111858	4163000	3752000	8.16	9.92	15.81
Madhya Pradesh	62.7	48.9	40.8	276858	384719	540505	174	457	519	33554982	43280535	52930829	19947293	20680000	20415000	4.70	6.72	9.49
Maharashtra	57.7	45.2	38.6	242611	393455	608913	1609	1545	1568	34011546	42164044	50071624	17451416	18896000	18016000	5.99	6.21	8.73
Orissa	67.3	67.5	49.9	136043	192406	182727	120	452	464	19699234	24033052	28344981	8717400	8553000	8639000	4.56	6.24	8.21
Punjab	28.2	13.2	12.5	155426	244228	406473	215	291	17	10147208	12538388	14763257	4215722	3479000	3098000	14.39	13.36	18.84
Rajasthan	44.8	33.5	27.5	212284	306308	310850	161	109	460	20741045	28294792	35517727	12763266	11826000	10529000	9.07	12.74	12.38
Tamil Nadu	57.4	54.0	32.6	256123	207906	339785	621	1580	2020	28302476	33278087	37713343	13543207	12493000	12073000	5.69	5.97	8.28
Uttar Pradesh	56.5	46.5	42.0	572232	780537	998801	503	956	583	74694149	94722615	116147860	29458928	29405000	29473000	6.79	8.17	11.04
West Bengal	73.2	63.1	40.3	209791	314522	494604	1919	2944	1189	32573455	41904585	51436039	10110995	11226000	10704000	7.84	6.40	14.33

Notes:
a For Rural Headcount Poverty, Haryana proportions were used for Himachal Pradesh
b Head Count Poverty was used to represent poor. Includes public distribution from both central and state governments
c Extrapolation used for the years 1970, 1973, 1986, 1989,1990,1992. Punjab proportions used for Himachal Pradesh.
d Punjab rates used for Haryana and Himachal Pradesh also

Sources:
1: Abhijit Sen, "Economic Reforms, Employment and Poverty: Trends and Options", *Economic and Political Weekly,* Special Number September, 1996, pg2466
2: National Accounts Statistics, EPW Research Foundation, 1999.
3: National Accounts Statistics, CSO, Various Issues and CD Rom
4: Census of India, 1971, 1981, 1991, Various Issues
5: Chaudhri, D.P. (1996), A Dynamic Profile of Child Labour in India 1951 - 1991, CLASP, ILO, New Delhi.
6: The World Bank, *India: Poverty, Employment and Social Services*, The World Bank Country Studies, 1989, Washington
7: Economic Survey 1998, 2000, Ministry of Finance, New Delhi, Various

Table 3b: Trends in Rural Poverty, Output and Public Distribution of Foodgrains in Major States of India, 1970-1993

	Road Density in Rural India (km per '000 square km) (ROAD)			Net area sown ('000 hectares) (NAS)			Proportion of Rural Population that is Literate (percent) (LIT)			Proportion of Cropped Area Irrigated (percent) (IRRIG)			Proportion of Cropped Area Sown with High Yeilding Varieties (percent) (HYV)			Proportion of Villages Electrified (percent) (ELEC)			Development Expenditure (1960-61 Rs million) (DEVEX)		
	1970	1983	1993	1970	1983	1993	1970	1983	1993	1970	1983	1993	1970	1983	1993	1970	1983	1993	1970	1983	1993
Andhra Pradesh	4603	6262	6968	11360.7	11435.0	10362.0	19.3	25.0	30.9	30.4	35.6	41.6	11.9	51.9	83.3	34.3	83.1	95.9	1083	4493	8003
Bihar	8590	12043	14668	8261.0	7580.0	7267.0	16.8	21.3	26.0	27.5	36.4	40.0	14.2	35.2	47.4	13.5	44.8	67.3	795	2494	4341
Gujarat	1702	2687	3584	9692.3	9617.0	9391.0	27.7	37.7	46.9	13.7	23.3	27.0	14.9	28.2	33.9	23.8	79.4	97.2	877	3682	5749
Haryana	4313	7043	7550	3550.0	3600.0	3513.0	24.7	28.9	32.9	39.7	66.4	75.9	20.5	70.4	68.9	68.1	100.0	100.0	344	1356	1781
Himachal Pradesh	2263	3369	3766	551.0	593.0	572.0	33.0	41.7	54.3	15.3	17.4	17.6	6.1	5.9	6.8	24.9	75.5	100.0	70	565	1044
Karnataka	3436	5488	7213	10129.0	10605.0	10790.0	23.1	30.3	36.0	12.4	16.6	24.4	10.4	38.4	47.5	57.8	89.8	100.0	753	2599	5253
Kerala	3434	4680	5328	2185.3	2180.0	2238.0	55.1	68.9	78.6	21.1	15.0	12.5	17.5	28.7	35.1	100.0	100.0	100.0	612	1619	2407
Madhya Pradesh	878	1619	2174	18436.3	19223.0	19740.0	17.3	22.3	29.9	8.5	11.6	18.3	5.1	32.5	43.6	11.7	49.9	91.9	770	3376	5327
Maharashtra	2160	4809	5650	16921.3	18302.0	18021.0	29.8	43.1	40.4	8.5	11.7	11.2	15.2	43.9	68.6	29.5	75.7	92.7	1504	5878	10580
Orissa	2641	7343	10814	5662.7	6301.0	6304.0	24.6	31.7	36.6	16.6	21.4	19.2	4.1	30.3	47.0	7.9	48.0	78.1	443	1262	2540
Punjab	2869	6224	8315	4071.7	4212.0	4214.0	26.7	36.3	45.9	74.5	85.2	93.0	55.8	88.7	93.3	50.5	99.6	100.0	449	1838	2201
Rajasthan	927	1358	1775	15100.3	16235.0	16232.0	13.1	18.9	25.7	14.7	22.7	27.2	4.8	14.1	20.5	63.6	65.4	81.4	709	2379	4146
Tamil Nadu	4299	9423	14251	6283.0	5846.0	5901.0	32.6	39.7	47.2	45.6	42.3	46.2	37.0	61.8	55.4	54.2	98.0	99.9	1155	3715	6689
Uttar Pradesh	931	1852	2680	17272.0	17273.0	17250.0	16.4	20.2	30.9	38.1	45.6	57.0	36.0	47.3	46.9	25.9	47.3	74.6	1252	5585	7351
West Bengal	5026	5549	6324	5437.0	5341.0	5459.0	27.9	33.0	45.6	20.3	26.7	33.3	12.4	35.5	48.0	8.8	51.7	78.8	842	2818	4539

Sources:
1: Abhijit Sen, "Economic Reforms, Employment and Poverty: Trends and Options", *Economic and Political Weekly*, Special Number September, 1996, pg2466
2: National Accounts Statistics, EPW Research Foundation, 1999.
3: National Accounts Statistics, CSO, Various Issues and CD Rom
4: Census of India, 1971, 1981, 1991, Various Issues
5: Chaudhri, D.P. (1996), A Dynamic Profile of Child Labour in India 1951 - 1991, CLASP, ILO, New Delhi.
6: The World Bank, *India: Poverty, Employment and Social Services*, The World Bank Country Studies, 1989, Washington
7: Economic Survey 1998, 2000, Ministry of Finance, New Delhi, Various

Table 4: Descriptive Statistics for Key Poverty Variables, Major States of India, 1970-1993

	Minimum	Maximum	Mean	Std. Deviation
RHCP	14.00	81.00	45.15	15.31
RPOP	3034107.71	116147859.94	34563628.50	23229910.61
SDPA	19897.72	1174546.30	303220.41	193675.16
AGEMP	2107000.00	29473000.00	11872415.95	7294196.28
RWAGE	0.72	68.00	2.76	5.25
PDGTG	2.00	2944.00	820.51	663.19
ROAD	878.00	14902.00	5272.01	3367.28
NAS	551.00	19740.00	9056.65	5755.00
LIT	13.07	78.60	33.55	12.99
IRRIG	6.92	93.02	31.81	20.73
HYV	4.10	96.94	38.82	23.42
ELEC	7.91	100.00	70.58	28.19
DEVEX	70.00	10580.00	2982.30	2355.44

Where:

RHCP: Rural poverty head-count ratio (proportion of rural poor over total rural population)
RPOP: Rural population (actual numbers)
SDPA: State agricultural domestic product at constant 1980-81 prices (Rs Lakh)
AGEMP: Agricultural employment (No's)
RWAGE: Rural wage rate (Rs per day in 1960/61 prices)
PDGTG: Public distribution of total food grains both from Central and State Governments (thousand tonnes)
ROAD: Road density in rural India (kilometers per thousand square kilometers)
NAS: Net Area Sown ('000 hectares)
LIT: Proportion of rural population that is literate (percent)
IRRIG: Proportion of cropped area irrigated (percent)
HYV: Proportion of cropped area sown with high yeilding varieties (percent)
ELEC: Proportion of villages electrified (percent)
DEVEX: Development expenditure (1960-61 Rs million)

Table 5: Correlation Matrix of Key Poverty Variables for the States of India, 1970-1993

	RHCP	RPOP	SDPA	AGEMP	RWAGE	PDGTG	ROAD	NAS	LIT	IRRIG	HYV	ELEC	DEVEX
RHCP	1.00	0.30	0.02	0.48	-0.04	0.19	-0.07	0.45	-0.34	-0.51	-0.43	-0.57	-0.08
RPOP	0.30	1.00	0.77	0.90	-0.06	0.29	0.09	0.60	-0.34	0.04	0.18	-0.21	0.60
SDPA	0.02	0.77	1.00	0.68	-0.13	0.17	-0.05	0.58	-0.26	0.24	0.40	0.05	0.63
AGEMP	0.48	0.90	0.68	1.00	-0.11	0.21	-0.08	0.78	-0.51	-0.13	0.05	-0.38	0.49
RWAGE	-0.04	-0.06	-0.13	-0.11	1.00	0.17	0.00	-0.13	0.04	0.01	-0.03	-0.08	-0.05
PDGTG	0.19	0.29	0.17	0.21	0.17	1.00	0.21	0.12	0.38	-0.26	0.11	0.15	0.51
ROAD	-0.07	0.09	-0.05	-0.08	0.00	0.21	1.00	-0.39	0.15	0.35	0.47	0.27	0.20
NAS	0.45	0.60	0.58	0.78	-0.13	0.12	-0.39	1.00	-0.51	-0.28	-0.01	-0.25	0.47
LIT	-0.34	-0.34	-0.26	-0.51	0.04	0.38	0.15	-0.51	1.00	-0.07	0.07	0.59	0.09
IRRIG	-0.51	0.04	0.24	-0.13	0.01	-0.26	0.35	-0.28	-0.07	1.00	0.75	0.30	0.05
HYV	-0.43	0.18	0.40	0.05	-0.03	0.11	0.47	-0.01	0.07	0.75	1.00	0.50	0.47
ELEC	-0.57	-0.21	0.05	-0.38	-0.08	0.15	0.27	-0.25	0.59	0.30	0.50	1.00	0.40
DEVEX	-0.08	0.60	0.63	0.49	-0.05	0.51	0.20	0.47	0.09	0.05	0.47	0.40	1.00

Where:

RHCP: Rural poverty head-count ratio (proportion of rural poor over total rural population)
RPOP: Rural population (actual numbers)
SDPA: State agricultural domestic product at constant 1980-81 prices (Rs Lakh)
AGEMP: Agricultural employment (No's), (Extrapolation used for the years 1970, 1973, 1986, 1989,1990,1992. Punjab figures used for Himachal Pradesh.)
RWAGE: Rural wage rate (Rs per day in 1960/61 prices) (Punjab figures used for Himachal Pradesh.)
PDGTG: Public distribution of total food grains both from Central and State Governments (thousand tonnes)
ROAD: Road density in rural India (kilometers per thousand square kilometers)
NAS: Net Area Sown ('000 hectares)
LIT: Proportion of rural population that is literate (percent)
IRRIG: Proportion of cropped area irrigated (percent)
HYV: Proportion of cropped area sown with high yeilding varieties (percent)
ELEC: Proportion of villages electrified (percent)
DEVEX: Development expenditure (1960-61 Rs million)

Table 6: Augmented Dickey - Fuller Unit Root Tests of Stationarity[a b]

	Variable[c]											
State	**SDPA**	**AGEMP**	**RHCP**	**PDGTG**	**RPOP**	**RWAGE**	**NAS**	**ELEC**	**ROAD**	**LIT**	**IRRIG**	**DEVEX**
Andhra Pradesh	-3.137 (2)	-1.354 (1)	-2.276 (1)	-1.361 (2)	**-3.480 (2) d**	-1.375 (2)	-2.597 (0)	**-8.595 (2) d**	**-4.933 (0) d e**	**-6.555 (2) d**	**-4.159 (2) d e**	-1.426 (0)
Bihar	-3.174 (0)	-2.032 (1)	-1.901 (0)	-2.158 (0)	**-3.417 (0) d**	-2.988 (0)	-2.552 (2)	**-8.866 (2) d e**	-1.718 (1)	-1.978 (1)	**-5.596 (1) d**	-1.594 (1)
Gujarat	-2.828 (2)	-1.162 (0)	-1.698 (0)	-2.022 (0)	**-5.193 (2) d**	-3.218 (0)	-2.717 (2)	-3.460 (2) **d**	-0.713 (0)	**-3.713 (2) d**	-2.285 (0)	-1.170 (0)
Haryana	**-8.238 (0) d e**	**-6.171 (2) d**	-1.042 (0)	-2.649 (0)	**-3.712 (2) d**	-4.014 (0)	-3.082 (0)	**-8.483 (2) d e**	**-10.759 (2) d e**	-2.883 (1)	-4.064 (1)	-1.209 (0)
Himachal Pradesh	-1.959 (0)	**-3.580 (0) d**	-1.088 (0)	**-6.863 (2) d**	**-5.571 (2) d**	**-4.730 (0) e**	-2.841 (0)	**-3.409 (1) d**	**-4.213 (0) d e**	-1.730 (1)	-3.440 (0)	**-3.352 (2) d**
Karnataka	-0.546 (0)	-1.897 (1)	-1.924 (2)	**-5.209 (0) d e**	**-4.026 (2) d**	-2.595 (0)	-2.083 (0)	-2.999 (1)	**-3.732 (0) d**	**-4.009 (2) d**	-1.171 (0)	-0.806 (2)
Kerala	-0.315 (0)	-2.867 (2)	-2.094 (0)	-3.193 (0)	**-7.580 (2) d**	-2.956 (0)	-1.119 (0)	**C d e**	**-5.004 (2) d**	**-4.219 (2) d**	-3.446 (0)	-1.367 (0)
Madhya Pradesh	-4.163 (2)	-2.390 (0)	-1.990 (0)	-1.688 (0)	**-3.773 (2) d**	-3.633 (0)	-4.059 (0)	-1.173 (0)	**-4.476 (2) d**	-1.640 (1)	-2.693 (2)	-1.412 (0)
Maharashtra	**-4.686 (2) e**	-1.559 (0)	-2.393 (0)	-3.496 (0) **d**	**-3.590 (2) d**	-2.112 (0)	**-3.609 (0) d e**	**-5.607 (0) d**	**-6.834 (0) d e**	-1.640 (1)	-2.693 (2)	-2.471 (0)
Orissa	-3.174 (0)	-1.420 (1)	-2.444 (2)	-0.029 (2)	**-3.436 (2) d**	-3.907 (0)	-3.323 (0)	-9.731 (2) **d e**	**-6.013 (2) d**	**-3.972 (0) d**	2.621 (2)	-1.282 (0)
Punjab	**-3.537 (0) d**	**-3.580 (0) d**	-1.195 (0)	-3.182 (0)	**-3.738 (2) d**	**-4.730 (0) e**	**-4.401 (0) d**	**C d e**	**-4.533 (2) d e**	**-4.340 (2) d**	-1.109 (0)	-1.056 (0)
Rajasthan	-4.016 (2)	-1.352 (0)	-1.865 (2)	-2.596 (1)	**-3.939 (2) d**	-2.235 (0)	-2.254 (0)	-1.630 (1)	**-4.191 (0) d**	**-4.137 (2) d**	-2.785 (0)	-1.419 (0)
Tamil Nadu	-1.474 (0)	-0.597 (0)	-2.913 (0)	**-16.183 (0) d e**	**-3.754 (2) d**	-3.539 (0)	-1.940 (0)	**-16.920 (2) d e**	**-15.069 (2) d**	-1.481 (0)	**-3.621 (0) d**	-1.814 (0)
Uttah Pradesh	**-7.391 (2) d**	-2.725 (0)	-2.056 (0)	-3.434 (0) **d**	**-3.423 (0) d**	-3.238 (0)	-1.973 (0)	-2.587 (0)	-1.466 (0)	-3.668 (2)	-1.607 (2)	-1.117 (0)
West Bengal	-3.436 (0)	-6.083 (2)	-3.874 (2)	-4.864 (2) **d e**	**-3.511 (2) d**	-6.083 (2) **e**	-2.792 (2)	**-9.516 (0) d**	-2.698 (0)	-0.837 (0)	-2.851 (2)	-1.868 (1)
INDIA	**-4.495 (0) f g**	-2.667 (0)	**-3.885 (0) f g**	**-4.253 (0) f g**	-2.354 (0)	**-6.692 (0) f g**	**-2.921 (1) f g**	**-6.231 (2) f g**	**-3.895 (0) f g**	**-3.854 (0) f g**	**-3.272 (0) f**	**-5.284 (0) f g**

Notes:

(a): The entries in bold denote stationarity: the rejection of the null hypothesis of the existence of a unit root, Ho: ϕ=1

(b): The value in parenthesis is the optimum lag of the ADF regression according to the maximum value of the Shwarz Bayesian Criterion (SBC)

(c): All Variables are in Naperian logs

(d): Reject H_0 at the 5% level. The actual value for the ADF refression with intercept is -3.3353

(e): Reject H_0 at the 5% level. The actual value for the ADF refression with intercept and with time trend is -4.1961

(f): Reject H_0 at the 5% level. The actual value for the ADF refression with intercept is -2.8802

(g): Reject H_0 at the 5% level. The actual value for the ADF refression with intercept and with time trend is -3.4396

(h): 'C' denotes an absolute stationarity in terms of the variable being constant for the state

(i):
SDPA State agricultural domestic product at constant 1980-81 prices (Rs)
AGEMP Agricultural employment (No's), (Extrapolation used for the years 1970, 1973, 1986, 1989,1990,1992. Punjab figures used for Himachal Pradesh.)
RHCP Rural poverty head-count ratio (proportion rural poor over total rural population)
PDGTG Public distribution of total food grains both from Central and State Govts. (thousand tonnes)
RWAGE Rural wage rate (Rs per day in 1960/61 prices) (Punjab figures used for Himachal Pradesh.)
NAS Net area sown ('000 hectares)
ELEC Proportion of villages electrified (percent)
ROAD Road density in rural India (kilometers per thousand square kilometers)
LIT Proportion of rural population that is literate (Percent)
IRRIG Proportion of cropped area irrigated (Percent)
DEVEX Development expenditure (1960-61 Rs million)

Table 7a: Adjusted Coefficients of Determination For Each Variable by State[a]: State Domestic Product Equation Variables

	Variable[b]					
State	**SDPA**	**AGEMP**	**NAS**	**ELEC**	**ROAD**	**IRRIG**
Andhra Pradesh	0.96	0.49	0.81	0.99	0.99	0.97
Bihar	0.73	0.70	0.88	0.99	0.99	0.99
Gujarat	0.83	0.94	0.94	0.99	0.99	0.99
Haryana	0.54	0.94	0.17	0.92	0.99	0.96
Himachal Pradesh	0.87	0.97	0.85	0.99	0.98	0.88
Karnataka	0.90	0.75	0.89	0.97	0.97	0.91
Kerala	1.00*	1.00*	1.00*	1.00*	1.00*	1.00*
Madhya Pradesh	0.93	0.45	0.49	0.99	0.99	0.51
Maharasthra	0.83	0.23	0.73	0.99	0.99	0.88
Orissa	0.58	0.78	0.93	0.92	0.96	0.78
Punjab	0.99	0.97	0.84	0.99	0.998*	0.99
Rajasthan	0.88	0.96	0.87	0.83	0.99	0.97
Tamil Nadu	0.93	0.92	0.96	0.96	0.99	0.75
Uttah Pradesh	0.98	0.20	0.64	0.999*	0.997*	0.99
West Bengal	0.82	0.85	0.57	0.96	0.99	0.99
INDIA[d]	**0.86**	**0.99**	**0.99**	**0.80**	**0.95**	**0.95**

Notes:
(a): Each cell represents the adjusted coefficient of determination of the variable against all other five variables by state.
(b): All variables are in Naperian Logs
(c): * Correlation matrix is near singular
(d): Dummy variables for each state were used in these regressions
(e): SDPA — State agricultural domestic product at constant 1980-81 prices (Rs Lakh)
AGEMP — Agricultural employment (no's), (Extrapolation used for the years 1970, 1973, 1986, 1989,1990,1992. Punjab figures used for Himachal Pradesh.)
NAS — Net Area Sown ('000 hectares)
ELEC — Proportion of villages electrified (percent).
ROAD — Road density in rural India (kilometers per thousand square kilometers)
IRRIG — Proportion of cropped area irrigated (percent)

Table 7b: Adjusted Coefficients of Determination For Each Variable by State[a]: Agricultural Employment Equation Variables

	Variable[b]			
State	**AGEMP**	**SDPA**	**RHCP**	**RWAGE**
Andhra Pradesh	0.42	0.77	0.75	0.55
Bihar	0.88	0.93	0.98	0.95
Gujarat	0.88	0.49	0.52	0.82
Haryana	0.71	0.22	0.55	0.52
Himachal Pradesh	0.84	0.86	0.54	0.45
Karnataka	0.29	0.48	0.40	0.44
Kerala	0.49	0.78	0.64	0.77
Madhya Pradesh	0.28	0.85	0.75	0.73
Maharasthra	0.60	0.67	0.60	0.79
Orissa	0.37	0.24	0.71	0.67
Punjab	0.92	0.93	0.61	0.43
Rajasthan	0.28	0.64	0.84	0.83
Tamil Nadu	0.90	0.70	0.82	0.79
Uttah Pradesh	0.82	0.72	0.60	0.66
West Bengal	0.15	0.84	0.55	0.76
INDIA[c]	**0.99**	**0.84**	**0.81**	**0.53**

Notes:

(a): Each cell represents the adjusted coefficient of determination of the variable against all other three variables by state.

(b): All variables are in Naperian Logs

(c): Dummy variables for each state were used for these regressions

(d): AGEMP — Agricultural employment (no's), (Extrapolation used for the years 1970, 1973, 1986, 1989,1990,1992. Punjab figures used for Himachal Pradesh.)

RHCP — Rural poverty head-count ratio (proportion rural poor over total rural population)

SDPA — State agricultural domestic product at constant 1980-81 prices (Rs Lakh)

RWAGE — Rural wage rate (Rs per day in 1960/61 prices) (Punjab figures used for Himachal Pradesh.)

Table 7c: Adjusted Coefficients of Determination For Each Variable by State[a]: Rural Head Count Poverty Equation Variables

	Variable[b]					
State	**RHCP**	**RPOP**	**SDPA**	**AGEMP**	**PDGTG**	**LIT**
Andhra Pradesh	0.84	0.99	0.87	0.75	0.92	0.99
Bihar	0.94	0.99	0.85	0.88	0.45	0.99
Gujarat	0.84	0.99	0.51	0.79	0.75	0.99
Haryana	0.69	0.99	0.19	0.99	0.41	0.99
Himachal Pradesh	0.45	0.99	0.89	0.94	0.94	0.99
Karnataka	0.58	0.99	0.92	0.39	0.83	0.99
Kerala	0.99	0.99	0.99	0.89	0.96	0.99
Madhya Pradesh	0.76	0.99	0.97	0.38	0.90	0.99
Maharasthra	0.60	0.91	0.85	0.20	0.22	0.77
Orissa	0.82	0.99	0.66	0.38	0.63	0.99
Punjab	0.80	0.99	0.99	0.97	0.69	0.99
Rajasthan	0.86	0.99	0.82	0.91	0.75	0.99
Tamil Nadu	0.88	0.99	0.61	0.88	0.72	0.99
Uttah Pradesh	0.66	0.99	0.97	0.57	0.44	0.98
West Bengal	0.92	0.99	0.53	0.55	0.79	0.99
INDIA[c]	**0.85**	**0.99**	**0.87**	**0.99**	**0.75**	**0.99**

Notes:

(a): Each cell represents the adjusted coefficient of determination of the variable against all other five variables by state.
(b): All variables are in Naperian Logs
(c): Dummy variables for each state were used in these regressions
(d):
RHCP — Rural poverty head-count ratio (proportion of rural poor over total rural population)
RPOP — Rural population (actual numbers)
SDPA — State agricultural domestic product at constant 1980-81 prices (Rs Lakh)
AGEMP — Agricultural employment (No's), (Extrapolation used for the years 1970, 1973, 1986, 1989,1990,1992. Punjab figures used for Himachal Pradesh.)
PDGTG — Public distribution of total food grains both from Central and State Governments (thousand tonnes)
LIT — Proportion of rural population that is literate (percent)

Table 7d: Adjusted Coefficients of Determination For Each Variable by State[a]: Public Distribution of Total Food Grains Equation Variables

	Variable[b]		
State	**DEVEX**	**RHCP**	**LIT**
Andhra Pradesh	0.92	0.79	0.90
Bihar	0.94	0.46	0.93
Gujarat	0.96	0.71	0.94
Haryana	0.91	0.44	0.88
Himachal Pradesh	0.82	0.34	0.78
Karnataka	0.93	0.41	0.93
Kerala	0.93	0.97	0.98
Madhya Pradesh	0.92	0.73	0.90
Maharasthra	0.87	0.65	0.73
Orissa	0.93	0.71	0.92
Punjab	0.88	0.50	0.86
Rajasthan	0.91	0.59	0.93
Tamil Nadu	0.90	0.82	0.93
Uttah Pradesh	0.92	0.25	0.80
West Bengal	0.84	0.86	0.90
INDIA[c]	**0.92**	**0.85**	**0.97**

Notes:
(a): Each cell represents the adjusted coefficient of determination of the variable against all other two variables by state.
(b): All variables are in Naperian Logs
(c): Dummy variables for each state were used for these regressions
(d): DEVEX Development expenditure (1960-61 Rs million)
RHCP Rural poverty head-count ratio (proportion of rural poor over total rural population)
LIT Proportion of rural population that is literate (percent)

Table 7e: Adjusted Coefficients of Determination For Each Variable by State[a]: Rural Wage Equation Variables

	Variable[b]		
State	**AGEMP**	**IRRIG**	**LIT**
Andhra Pradesh	0.14*	0.94	0.94
Bihar	0.35	0.94	0.95
Gujarat	0.36	0.96	0.97
Haryana	0.98	0.94	0.99
Himachal Pradesh	0.86	0.43	0.83
Karnataka	0.19*	0.89	0.89
Kerala	0.37	0.62	0.73
Madhya Pradesh	0.01*	0.28	0.28
Maharasthra	0.15*	0.81	0.80
Orissa	0.49	0.65	0.40
Punjab	0.89	0.95	0.96
Rajasthan	0.60	0.89	0.92
Tamil Nadu	0.69	0.12*	0.67
Uttah Pradesh	0.30	0.96	0.96
West Bengal	0.55	0.96	0.95
INDIA[c]	**0.99**	**0.94**	**0.97**

Notes:
(a): Each cell represents the adjusted coefficient of determination of the variable against all other two variables by state.
(b): All variables are in Naperian Logs
(c): Dummy variables for each state were used for these regressions
(d): * The unadjusted coefficient of determination is reported for these values as the adjusted coefficient was negative
(e):
AGEMP — Agricultural employment (No's), (Extrapolation used for the years 1970, 1973, 1986, 1989,1990,1992. Punjab figures used for Himachal Pradesh.)
IRRIG — Proportion of cropped area irrigated (percent)
LIT — Proportion of rural population that is literate (percent)

Table 8: Adjusted Coefficients of Determination for each Endogenous Variable against Instrumental Variables for each Five Equations

	Endogenous Variables For which Instruments were Obtained				
Equation:	SDPA	AGEMP	RHCP	PDGTG	RWAGE
State Domestic Product	-	0.99	-	-	-
Agricultural Employment	0.85	-	0.85	-	0.50
Rural Head Count Poverty	0.83	0.99	-	0.74	-
Public Distribution of Food Grains	-	-	0.82	-	-
Rural Wages	-	0.99	-	-	-

Notes:

Instruments used for endogenous variables in each equation are:	
State Domestic Product	Proportion of rural population that is literate (percent) Development expenditure (1960-61 Rs million)) Rural population (actual numbers)
Agricultural Employment	Proportion of villages electrified (percent) Road density in rural India (kilometers per thousand square kilometers) Proportion of cropped area irrigated (percent) Proportion of rural population that is literate (percent) Development expenditure (1960-61 Rs million)) Rural population (actual numbers)
Rural Head Count Poverty	Proportion of villages electrified (percent) Road density in rural India (kilometers per thousand square kilometers) Proportion of cropped area irrigated (percent) Development expenditure (1960-61 Rs million))
Public Distribution of Food Grains	Proportion of villages electrified (percent) Road density in rural India (kilometers per thousand square kilometers) Proportion of cropped area irrigated (percent)
Rural Wages	Proportion of villages electrified (percent) Road density in rural India (kilometers per thousand square kilometers) Proportion of cropped area irrigated (percent) Development expenditure (1960-61 Rs million))

Table 9: Test for Structural Change: 1970-1993, Forward CUSUM Squared Test

	Regression				
State	SDPA	AGEMP	RHCP	PDGTG	RWAGE
Andhra Pradesh	-	-	-	-	89*
Bihar	90*	87*	-	-	89*
Gujarat	-	-	92_C*	-	83*
Haryana	90*	-	89_C**	-	-
Himachal Pradesh	89**	-	-	-	-
Karnataka	-	-	-	-	-
Kerala					
Madhya Pradesh	-	-	-	-	-
Maharasthra	-	-	-	-	87_C**
Orissa	-	-	-	-	93_C*
Rajasthan	-	-	86_B*	87**	87**
Tamil Nadu	93_C*	-	-	83**	89_C**
Uttah Pradesh	-	-	-	-	86*
West Bengal	-	89_C**	-	-	
Punjab	-	93_C*	-	-	83**

Notes:
Year 19XY is shown as XY in the table
* * significant at 5%
* significant at 10%
C cusum test statistic
B backward cusum squared test statistic

Table 10a: Estimated Co-efficients of the Determinants of Agricultural State Domestic Product in Major States of India 1970 - 1993

Dependent Variable: Agricultural SDP		Instrumental variables estimates, using principle components			
		Full Sample, 1970-93		Structural Change Effects, 1989-93	
N=165		Co-efficients	t-values	Co-efficients	t-values
X1	Agricultural Employment	0.177	4.423***	0.006	0.668
X2	Net Area Sown	0.538	16.560***	0.084	10.580***
X3	Percent of Electrification	0.172	3.657***	-0.018	-3.290***
X4	Road	0.064	1.797*	-0.042	-3.671***
X5	Irrigation	0.317	8.288***	0.021	2.019*
D77		0.039	0.416		
D1	Andhra Pradesh	0.116	3.250***	0.048	2.993***
D2	Bihar	-0.031	0.951	0.014	0.993
D3	Gujarat	-0.029	-0.767	-0.009	-0.540
D4	Haryana	0.077	3.133***	0.024	2.067**
D5	Himachal Pradesh	-0.289	-8.261***	-0.122	-7.596***
D6	Karnataka	-0.200	-3.609***	-0.091	-3.683***
D7	Kerala	0.158	2.723***	0.065	2.489**
D8	Madhya Pradesh	0.100	2.244**	0.057	2.841***
D9	Maharashtra	-0.017	-1.291	-0.005	-0.988
D10	Orissa	-0.138	-2.649**	-0.057	-2.404**
D11	Rajasthan	0.018	0.360	0.008	0.349
D12	Tamil Nadu	0.011	0.224	-0.006	-0.270
D13	Uttar Pradesh	0.019	0.640	0.009	0.706
D14	West Bengal	0.087	2.066**	0.045	2.442**
C	Punjab	2.462	3.487***		
		$r^2 = 0.817$		S.E. = 0.326	

Notes:
(a) The r^2 denotes the r-square between observed and predicted values.
(b) * t-ratio significant at 10%, **t - ratio significant at 5% and *** t-ratio significant at 1%.
(c) All variables including instruments (but not dummy variables) are in Naperian Logs
(d) Explanatory Variables:

Y_1 = State agricultural domestic product at constant 1980-81 prices (Rs Lakh)
X_1 = Agricultural employment (No's)
X_2 = Net area sown ('000 hectares)
X_3 = Proportion of villages electrified (percent)
X_4 = Road density in rural India (kilometres per thousand square kilometres)
X_5 = Proportion of cropped area irrigated (percent)
C = Constant for Punjab
D_{1-14} = State dummy variables
D_{77} = Dummy variable for 1976-77 agricultural recession

Instrumental variables:

I_1 = Proportion of villages electrified (percent)
I_2 = Road density in rural India (kilometres per thousand square kilometres)
I_3 = Proportion of cropped area irrigated (percent)
I_4 = Proportion of rural population that is literate (percent)
I_5 = Development expenditure (1960-61 Rs million))
I_6 = Rural population (actual numbers)

Table 10b: Estimated Co-efficients of the Determinants of Agricultural Employment in Major States of India 1970 - 1993

Dependent Variable: Agricultural Employment	Instrumental variables estimates, using principle components			
	Full Sample, 1970-93		Structural Change Effects, 1989-93	
N = 165	Co-efficient	t-values	Co-efficient	t-values
X1 Agricultural SDP	0.441	10.930***	-0.002	-0.130
X2 Rural Head Count Poverty	0.499	9.637***	0.051	5.063***
X3 Rural Wage Rate	-0.432	-8.540***	-0.074	-8.505***
D77	0.061	0.849		
D1 Andhra Pradesh	-0.030	-1.494	-0.015	-1.638
D2 Bihar	0.093	1.948*	0.036	1.590
D3 Gujarat	0.089	2.455**	0.039	2.349**
D4 Haryana	-0.235	-6.831***	-0.096	-6.751***
D5 Himachal Pradesh	-0.183	-10.430***	-0.074	-9.244***
D6 Karnataka	0.110	3.566***	0.047	3.331***
D7 Kerala	-0.107	-1.798*	-0.052	-1.900*
D8 Madhya Pradesh	0.052	3.891***	0.019	2.250**
D9 Maharashtra	0.073	2.235**	0.027	1.836*
D10 Orissa	0.132	2.816***	0.054	2.624**
D11 Rajasthan	-0.010	-0.272	-0.009	-0.486
D12 Tamil Nadu	0.036	3.882***	0.007	1.875*
D13 Uttar Pradesh	-0.023	-0.887	-0.015	-1.374
D14 West Bengal	0.123	1.650	0.064	1.969*
C Punjab	9.032	17.960***		
	$r^2 = 0.720$		S.E. = 0.382	

Notes:
(a) The r^2 denotes the r-square between observed and predicted values.
(b) * t-ratio significant at 10%, **t - ratio significant at 5% and *** t-ratio significant at 1%.
(c) All variables including instruments (but not dummy variables) are in Naperian Logs
(d) Explanatory Variables

Y_1 = Agricultural employment (No's), (Extrapolation used for the years 1970, 1973, 1986, 1989, 1990, 1992. Punjab figures used for Himachal Pradesh.)
X_1 = State agricultural domestic product at constant 1980-81 prices (Rs Lakh)
X_2 = Rural poverty head-count ratio (proportion rural poor over total rural population)
X_3 = Rural wage rate (Rs per day in 1960/61 prices) (Punjab figures used for Himachal Pradesh.)
C = Constant for Punjab
D_{1-14} = State dummy variables
D_{77} = Dummy variable for 1976-77 agricultural recession

Instrumental variables
I_1 = Proportion of villages electrified (percent)
I_2 = Road density in rural India (kilometres per thousand square kilometres)
I_3 = Proportion of cropped area irrigated (percent)
I_4 = Proportion of rural population that is literate (percent)
I_5 = Development expenditure (1960-61 Rs million))
I_6 = Rural population (actual numbers)

Table 10c: Estimated Co-efficients of the Determinants of Rural Head Count Poverty in Major States of India 1970 - 1993

Dependent Variable Rural Head Count Poverty	Instrumental variables estimates, using principle components			
	Full Sample, 1970-93		Structural Change Effects, 1989-93	
	Co-efficient	t-values	Co-efficient	t-values
X1 Agricultural SDP	-0.111	-3.742***	-0.065	-7.985***
X2 Agricultural Employment	0.197	7.174***	0.005	1.158
X3 Public Distribution of Food Grains	0.101	4.878***	0.087	3.860***
X4 Literacy	-0.098	-3.495***	-0.021	-4.831***
X5 Rural Population	0.098	4.221***	-0.017	-2.844***
D77	0.093	1.352		
D1 Andhra Pradesh	0.095	3.854***	0.045	3.716***
D2 Bihar	0.169	4.048***	0.073	3.895***
D3 Gujarat	0.012	0.347	0.006	0.376
D4 Haryana	-0.074	-3.685***	-0.036	-3.548***
D5 Himachal Pradesh	-0.024	-1.126	-0.016	-1.689*
D6 Karnataka	0.074	2.023**	0.035	2.124**
D7 Kerala	-0.020	-0.800	0.002	0.144
D8 Madhya Pradesh	-0.019	-1.125	-0.013	-1.704*
D9 Maharashtra	-0.064	-1.339	-0.024	-1.138
D10 Orissa	0.102	3.602***	0.044	3.421***
D11 Rajasthan	0.006	0.119	0.000	-0.007
D12 Tamil Nadu	0.043	1.068	0.026	1.377
D13 Uttar Pradesh	-0.143	-3.644***	-0.068	-3.789***
D14 West Bengal	-0.076	-1.940	-0.035	-2.128**
C Punjab	0.054	0.115		
		r^2 = 0.632	S.E. = 0.238	

Notes:
(a) The r^2 denotes the r-square between observed and predicted values.
(b) * t-ratio significant at 10%, **t - ratio significant at 5% and *** t-ratio significant at 1%.
(c) All variables including instruments (but not dummy variables) are in Naperian Logs
(d) Explanatory Variables

Y_1 = Rural poverty head-count ratio (proportion rural poor over total rural population)
X_1 = State agricultural domestic product at constant 1980-81 prices (Rs Lakh)
X_2 = Agricultural employment (No's), (Extrapolation used for the years 1970, 1973, 1986, 1989,1990,1992. Punjab figures used for Himachal Pradesh.)
X_3 = Public distribution of total food grains from Central and State Govts. (thousand tonnes)
X_4 = Proportion of rural population that is literate (percent)
C = Constant for Punjab
D_{1-14} = State dummy variables
D_{77} = Dummy variable for 1976-77 agricultural recession

Instrumental Variables

I_1 = Proportion of villages electrified (percent)
I_2 = Road density in rural India (kilometres per thousand square kilometres)
I_3 = Proportion of cropped area irrigated (percent)
I_4 = Proportion of rural population that is literate (percent)
I_5 = Development expenditure (1960-61 Rs million))
I_6 = Rural population (actual numbers)

Table 10d: Estimated Co-efficients of the Determinants of Public Distribution of Total Food Grains in Major States of India 1970 - 1993

Dependent Variable: Public Distribution of Total Food Grains	Instrumental variables estimates, using principle components			
	Full Sample, 1970-93		Structural Change Effects, 1989-93	
	Co-efficient	t-values	Co-efficient	t-values
X1 Development Expenditure	0.828	12.180***	-0.024	-1.134
X2 Rural Head Count Poverty	0.899	8.607***	-0.100	-3.212***
X3 Literacy	0.508	5.317***	-0.024	-1.305
D77	0.307	1.837*		
D1 Andhra Pradesh	0.010	0.178	0.010	0.396
D2 Bihar	-0.148	-2.045**	-0.084	-2.570**
D3 Gujarat	0.031	0.699	0.000	-0.012
D4 Haryana	-0.665	-10.030***	-0.274	-9.925***
D5 Himachal Pradesh	-0.404	-11.230***	-0.162	-10.210***
D6 Karnataka	-0.184	-2.607***	-0.089	-2.766***
D7 Kerala	0.457	7.025***	0.189	6.714***
D8 Madhya Pradesh	0.018	0.769	-0.007	-0.744
D9 Maharashtra	0.248	4.882***	0.078	3.531***
D10 Orissa	0.338	4.337***	0.126	3.609***
D11 Rajasthan	-0.015	-0.265	0.007	0.283
D12 Tamil Nadu	0.212	6.614***	0.073	5.462***
D13 Uttar Pradesh	-0.143	-3.508***	-0.063	-3.552***
D14 West Bengal	0.458	4.244***	0.202	4.123***
C Punjab	-5.101	-7.623***		
		$r^2 = 0.678$	S.E. = 0.685	

Notes: (a) The r^2 denotes the r-square between observed and predicted values.
(b) * t-ratio significant at 10%, **t - ratio significant at 5% and *** t-ratio significant at 1%.
(c) All variables including instruments (but not dummy variables) are in Naperian Logs
(d) Explanatory Variables

Y_1 = Public distribution of total food grains, Central and State Governments (thousand tonnes)
X_1 = Development expenditure (1960-61 Rs million))
X_2 = Rural poverty head-count ratio (proportion of rural poor over total rural population)
X_3 = Proportion of rural population that is literate (percent)
C = Constant for Punjab
D_{1-14} = State dummy variables
D_{77} = Dummy variable for 1976-77 agricultural recession

Instrumental variables

I_1 = Proportion of villages electrified (percent)
I_2 = Road density in rural India (kilometres per thousand square kilometres)
I_3 = Proportion of cropped area irrigated (percent)
I_4 = Proportion of rural population that is literate (percent)
I_5 = Development expenditure (1960-61 Rs million))
I_6 = Rural population (actual numbers)

Table 10e: Estimated Co-efficients of the Determinants of Rural Wage Rates in Major States of India 1970 - 1993

Dependent Variable: Rural Wages	Instrumental variables estimates, using principle components			
	Full Sample, 1970-93		Structural Change Effects, 1989-93	
N=165	Co-efficient	t-values	Co-efficient	t-values
X1 Agricultural Employment	-0.279	-6.471***	0.039	3.762***
X2 Irrigation	0.089	1.832*	0.025	2.309**
X3 Literacy	0.040	0.675	0.025	3.127***
D77	0.002	0.020		
D1 Andhra Pradesh	-0.007	-0.534	-0.001	-0.136
D2 Bihar	0.017	0.523	0.010	0.675
D3 Gujarat	-0.064	-1.103	-0.028	-1.072
D4 Haryana	0.041	1.308	0.015	1.037
D5 Himachal Pradesh	0.056	2.514**	0.023	2.341**
D6 Karnataka	-0.061	-1.231	-0.025	-1.145
D7 Kerala	0.068	1.196	0.030	1.189
D8 Madhya Pradesh	-0.004	-0.142	0.001	0.122
D9 Maharashtra	-0.059	-2.105**	-0.023	-2.004**
D10 Orissa	-0.003	-0.264	-0.001	-0.147
D11 Rajasthan	0.041	0.918	0.020	1.053
D12 Tamil Nadu	-0.001	-0.044	0.001	0.076
D13 Uttar Pradesh	-0.032	-2.323**	-0.011	-1.949*
D14 West Bengal	-0.031	-1.315	-0.014	-1.248
C Punjab	4.693	5.793***		
	r^2 = 0. 346		S.E. = 0.429	

Notes: (a) The r^2 denotes the r-square between observed and predicted values.
(b) * t-ratio significant at 10%, **t - ratio significant at 5% and *** t-ratio significant at 1%.
(c) All variables including instruments (but not dummy variables) are in Naperian Logs
(d) Explanatory Variables

Y_1 = Rural wage rate (Rs per day in 1960/61 prices) (Punjab figures used for Himachal Pradesh.)
X_1 = Agricultural employment (No's), (Extrapolation used for the years 1970, 1973, 1986, 1989,1990,1992. Punjab figures used for Himachal Pradesh.)
X_2 = Proportion of cropped area irrigated (percent)
X_3 = Proportion of rural population that is literate (percent)
C = Constant for Punjab
$D_{1\text{-}14}$ = State dummy variables
D_{77} = Dummy variable for 1976-77 agricultural recession

Instrumental Variables
I_1 = Proportion of villages electrified (percent)
I_2 = Road density in rural India (kilometres per thousand square kilometres)
I_3 = Proportion of cropped area irrigated (percent)
I_4 = Proportion of rural population that is literate (percent)
I_5 = Development expenditure (1960-61 Rs million))
I_6 = Rural population (actual numbers)

Table 11a:

State Specific Reduced Form Effects - With No 1989-93 (Structural Change) Slope Dummies

	d77	c	dap	db	dg	dha	dhp	dka	dke	dmp	dma	do	dr	dtn	dup	dwb
SDPA	4.278	4.356	4.488	4.444	4.367	4.358	3.942	4.152	4.442	4.487	4.361	4.235	4.350	4.405	4.472	4.501
AGEMP	10.617	11.022	11.097	11.381	11.269	10.544	10.454	11.203	10.885	11.107	11.106	11.244	10.935	11.145	10.893	11.338
RHCP	1.232	1.694	1.794	1.961	1.785	1.437	1.498	1.851	1.733	1.647	1.684	1.924	1.640	1.793	1.441	1.728
PDGTG	1.587	2.289	2.409	2.363	2.456	1.362	1.742	2.236	2.754	2.261	2.596	2.833	2.119	2.651	1.922	2.752
RWAGE	1.933	1.604	1.571	1.523	1.465	1.778	1.826	1.495	1.695	1.601	1.521	1.542	1.698	1.542	1.602	1.475

Reduced Form Impact Elasticity multiplier - With No 1989-93 (Structural Change) Slope Dummies

	NAS	ELEC	ROAD	IRRIG	RPOP	LIT	DEVEX
SDPA	0.601	0.181	0.069	0.354	0.013	-0.009	-0.002
AGEMP	0.304	0.091	0.035	0.169	0.078	-0.054	-0.010
RHCP	-0.003	-0.001	0.000	-0.004	0.118	-0.067	-0.015
PDGTG	-0.003	-0.001	0.000	-0.004	0.111	0.483	-0.138
RWAGE	-0.086	-0.026	-0.010	-0.029	-0.022	0.034	0.003

Where

RHCP: Rural poverty head-count ratio (proportion of rural poor over total rural populat
RPOP: Rural population (actual numbers)
SDPA: State agricultural domestic product at constant 1980-81 prices (Rs Lakh)
AGEMP: Agricultural employment (No's)
RWAGE: Rural wage rate (Rs per day in 1960/61 prices) (Punjab figures used for Himac
PDGTG: Public distribution of total food grains both from Central and State Governmen
ROAD: Road density in rural India (kilometers per thousand square kilometers)
NAS: Net area sown ('000 hectares)
LIT: Proportion of rural population that is literate (percent)
IRRIG: Proportion of cropped area irrigated (percent)
HYV: Proportion of cropped area sown with high yeilding varieties (percent)
ELEC: Proportion of villages electrified (percent)
DEVEX: Development expenditure (1960-61 Rs million))
d77: Dummy variable for 1976-77 agricultural recession
C Constant for Punjab

dap: Dummy for Andhra Pradesh
db: Dummy for Bihar
dg: Dummy for Gujarat
dha: Dummy for Haryana
dhp: Dummy for Himachal Pradesh
dka: Dummy for Karnataka
dke: Dummy for Kerala
dmp: Dummy for Madhya Pradesh
dma: Dummy for Maharashtra
do: Dummy for Orissa
dp: Dummy for Punjab
dr: Dummy for Rajasthan
dtn: Dummy for Tamil Nadu
dup: Dummy for Uttah Pradesh
dwb: Dummy for West Bengal

Table 11b:

State Specific Reduced Form Effects - With No 1989-93 (Structural Change) Slope Dummies

	d77	C	dap	db	dg	dha	dhp	dka	dke	dmp	dma	do	dr	dtn	dup	dwb
SDPA	4.151	4.239	4.370	4.324	4.253	4.227	3.821	4.035	4.331	4.369	4.251	4.127	4.229	4.294	4.351	4.391
AGEMP	9.762	10.216	10.288	10.549	10.479	9.662	9.633	10.396	10.115	10.291	10.340	10.482	10.109	10.368	10.069	10.571
RHCP	0.791	1.359	1.464	1.617	1.475	0.946	1.117	1.522	1.472	1.293	1.404	1.690	1.276	1.514	1.037	1.457
PDGTG	1.146	1.925	2.045	1.981	2.110	0.868	1.345	1.871	2.456	1.882	2.282	2.551	1.731	2.333	1.506	2.444
RWAGE	2.631	2.309	2.281	2.251	2.178	2.479	2.508	2.209	2.385	2.313	2.221	2.247	2.404	2.246	2.306	2.186

Reduced Form Impact Elasticity multiplier - With No 1989-93 (Structural Change) Slope Dummies

	NAS	ELEC	ROAD	IRRIG	RPOP	LIT	DEVEX
SDPA	0.682	0.161	-0.322	0.371	0.010	-0.005	-0.008
AGEMP	0.300	0.071	-0.142	0.139	0.059	-0.029	-0.046
RHCP	-0.079	-0.019	0.037	-0.049	0.100	-0.010	-0.079
PDGTG	-0.071	-0.017	0.033	-0.044	0.090	0.502	-0.317
RWAGE	-0.071	-0.017	0.034	0.004	-0.014	0.045	0.011

Where

RHCP: Rural poverty head-count ratio (proportion of rural poor over total rural population)
RPOP: Rural population (actual numbers)
SDPA: State agricultural domestic product at constant 1980-81 prices (Rs Lakh)
AGEMP: Agricultural employment (No's)
RWAGE: Rural wage rate (Rs per day in 1960/61 prices) (Punjab figures used for Himachal Pradesh.)
PDGTG: Public distribution of total food grains both from Central and State Governments (thousand tonne
ROAD: Road density in rural India (kilometers per thousand square kilometers)
NAS: Net area sown ('000 hectares)
LIT: Proportion of rural population that is literate (percent)
IRRIG: Proportion of cropped area irrigated (percent)
HYV: Proportion of cropped area sown with high yeilding varieties (percent)
ELEC: Proportion of villages electrified (percent)
DEVEX: Development expenditure (1960-61 Rs million))
d77: Dummy variable for 1976-77 agricultural recession
C Constant for Punjab

dap: Dummy for Andhra Pradesh
db: Dummy for Bihar
dg: Dummy for Gujarat
dha: Dummy for Haryana
dhp: Dummy for Himachal Pradesh
dka: Dummy for Karnataka
dke: Dummy for Kerala
dmp: Dummy for Madhya Pradesh
dma: Dummy for Maharashtra
do: Dummy for Orissa
dp: Dummy for Punjab
dr: Dummy for Rajasthan
dtn: Dummy for Tamil Nadu
dup: Dummy for Uttah Pradesh
dwb: Dummy for West Bengal

APPENDIX

Table A1 : Estimates of Rural Poverty in the Major States of India 1971, 1981, 1991

Dependant Variable: *Log Rural Head Count Poverty*		Pooled	
Explanatory Variables:		β	t-ratio
Log Net Agricultural SDP (1980-81 Prices, Rs.) Per Agricultural Worker		*-0.47*	*-12.29****
Log Public Distribution of Total Grains per Rural Poor Person		*-0.15*	*-8.66****
Constant		*8.32*	*30.12****
Buse R^2 = 0.9994	*SE* = 1.0135		*N* = 45

Rho Vector

0.732	0.206	0.109	-0.993	0.905
-0.393	0.987	-0.840	0.261	0.181
0.575	-0.088	0.037	0.622	0.992

Same Estimated Rho for All Cross-Sections = 0.55964

Variances (Diagonal of Phi Matrix)#

10.85	1.67	5.29	1.61	7.88
2.50	3.65	0.21	3.10	11.43
19.38	3.61	37.74	1.40	1.88

values are reported $x10^{-2}$

Notes: * t-ratio significant ratio at 10%, ** t-ratio significant at 5%, ***t-ratio significant at 1%

Table A2: Time Series Estimates of Rural Poverty
All-India: 1966-67 to 1996-97

Dependant Variable: *Log Rural Head Count Poverty*

Explanatory Variables:	OLS b	**t-ratio**
Log Net Agricultural GDP (Rs.) Per Rural Person	*-1.10*	*-6.17****
Log Public Distribution of Total Grains per Poor Person	*-0.41*	*-4.84****
Constant	*13.871*	*13.05****

Adjusted R^2=0.864 *SE*=0.078 *N*=20 Durbin Watson=1.408

Notes: * t-ratio significant ratio at 10%, ** t-ratio significant at 5%, ***t-ratio significant at 1%

Sequential Chow and Goldfeld-Quandt Tests

Year	Chow	Goldfeld-Quandt	(DF_1, DF_2)
1969-70	4.65**	0.001	(1,13)
1970-71	4.51**	0.107	(2,12)
1972-73	3.32**	0.969	(3,11)
1973-74	3.82**	0.832	(4,10)
1977-78	4.00**	0.937	(5,9)
1982-83	2.78*	1.335	(6,8)
1986-87	2.40*	1.113	(7,7)
1987-88	2.42*	0.854	(8,6)
1988-89	0.95	1.062	(9,5)
1989-90	1.48	1.107	(10,4)
1990-91	1.79	0.947	(11,3)
1991-92	1.43	0.680	(12,2)
1992-93	0.77	4.736	(13,1)

Notes: * 2.39=significant 10%, ** 3.11=significant at 5%, , *** 5.04=significant at 1%

Table A3: Changes in the Trend of Poverty
All-India: 1966-67 to 1996-97

OLS Equation:

Dependant Variable: ***Rural Head Count Poverty***

Independent Variables: ***Time***

Sequential Chow and Goldfeld-Quandt Tests

Year	Chow	Goldfeld-Quandt	(DF_1, DF_2)
1968-69	1.97	0.28	(1,15)
1969-70	2.09	0.14	(2,14)
1970-71	2.11	0.09	(3,13)
1972-73	1.64	0.29	(4,12)
1973-74	2.61*	0.41	(5,11)
1977-78	4.89***	0.44	(6,10)
1982-83	8.34***	0.49	(7,9)
1986-87	8.16***	0.40	(8,8)
1987-88	8.45***	0.33	(9,7)
1988-89	8.72***	0.28	(10,6)
1989-90	10.63***	0.34	(11,5)
1990-91	14.06***	0.36	(12,4)
1991-92	20.57***	1.10	(13,3)
1992-93	3.61**	2.39	(14,2)
1993-94	2.85*	8.53	(15,1)

Notes: * 2.33=significant 10%, ** 3.01=significant at 5%, , ***4.77=significant at 1%

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