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Some Empirical Results and a Research Agenda
based on the Literature**

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Agricultural Economy of India and Macro-Economic Effects: Some Empirical Results and a Research Agenda based on the Literature

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Abstract

This paper focuses on macroeconomic linkages with agriculture. From an extensive literature review the question that emerges is: is there a structural constraint in Indian agriculture or does Indian agriculture work in a system in which as demand rises and prices rise, supply responds. The constraints maybe institutional or policy determined in the foodgrains part of the economy, with the non foodgrain economy being responsive to market forces. These kind of general hypotheses lead to analysis of macroeconomic policy variables particularly of impacts of government expenditure and money supply. What are the impacts of such policies on agricultural prices and interest rates for agriculture? How do they impact on agricultural demand, supplies and investment?

If expansionary/ contractionary macro policy (Monetary-Fiscal policy mix) leads to rise/fall in money income, it will impact significantly on agricultural demand. Does this then lead to fluctuations in agricultural supply? There are many ways to analyze this kind of question. We use a partial economy framework using lags to help the specifications of our model. A Causal Chain model demonstrates econometrically that macro policies impact agriculture in a significant manner. The farm-nonfarm ratio determines supply with a Nerlovian lag and the model predicts supply oscillations in the non foodgrain agricultural economy. The work has possibilities of more complicated policy simulations of macro policy impacts on agriculture.

Agricultural Economy of India and Macro-Economic Effects: Some Empirical Results and a Research Agenda based on the Literature

Introduction

This paper focuses on macroeconomic linkages with agriculture. We differentiate between alternative ways of looking at Indian agriculture. The first is the Structuralist Theory which says that markets are not highly developed in India so even when there are unemployed resources, an increase in demand will not lead to output rising and there will be inflation. Macroeconomic policy whereas may impact demand but will not influence supply, which will depend largely on agricultural specific and institutional factors. The alternative viewpoint is the Keynesian Theory that with unemployed resources in agriculture, the impact of expansionary policies on demand will lead to rising production. Expansionary policies will have a positive impact on agriculture in terms of rising production and market equilibrating prices. Again the Monetarist approach assumes the near full employment of resources and stable relations between the demand for money and income. There can also be hybrids of these approaches. For example in the work of structuralists like Lance Taylor, elements of the Keynesian approach are also there. Again in some analysis, markets work in some parts of the agrarian economy and not in others (Munish Alagh,2011). Bringing in time as an element of analysis, there are alternative views on the stabilizing or destabilizing nature of outcomes and policies, in these approaches.

Agriculture continues to be important in India's economy, although the contribution in terms of share of GDP has been taken over by services and now is close to 15%. It contributed half of the share to employment, contributes to exports, is a source of raw-materials and is also a source of demand for many industries. Wage goods inflation in terms of food prices is a major policy concern in the growth process. The question asked on the recent trend of food inflation is whether it is due to supply-demand imbalances with low agricultural growth facing the demands of a high growth economy arising from technological bottlenecks, or alternately vulnerability to trade and commodity futures or lack of institutional reform. Many agricultural economists believe that lack of institutional reform is the predominant cause, leading to the other problems becoming binding constraints. So the question that emerges is: is there a structural constraint in

Indian agriculture or does Indian agriculture work in a system in which as demand rises and prices rise, supply responds. Alternately mixed or mongrel kind of explanations may be possible. For example, the constraints maybe institutional or policy determined in the foodgrains part of the economy, with the non foodgrain economy is being responsive to market and non price factors mattering particularly in that part of agriculture not responding to prices (M.Alagh, 2011).

These kind of general hypotheses will require an analysis of macroeconomic policy particularly of trends and impacts of government expenditure and money supply. What are the impacts of such policies on agricultural prices and interest rates for agriculture? How do they impact on agricultural demand, supplies and investment? Do monetary shocks and budget deficits affect farm output and the farm-non farm price ratio? These kind of questions have gained urgency in recent discussions both of agricultural and macro policies.

Monetary and Fiscal Policy Mixes

In evaluating the impact of macroeconomic policy changes, the mix of monetary and fiscal policies has to be evaluated. A combination of both restrictive fiscal and monetary policies will restrict growth of an economy and may lead to a recession or depression with harmful impacts on all sectors. An overly expansionary fiscal policy combined with an excessively expansionary monetary policy will lead to rapid inflation and, thus, is another policy mix which is generally not followed. The other two combinations, expansionary fiscal policy coupled with restrictive monetary policy or restrictive fiscal policy coupled with expansionary monetary policy, are policy mixes which are common.

Macroeconomic policy changes therefore affect the agricultural economy through their impacts on interest rates and inflation. Changing interest rates influence variable production costs, long-term capital investments, cash flow, land values, and exchange rates, while inflation affects input prices, commodity prices, real interest rates and land prices. Given the growing integration of the world economy, future domestic and foreign policy changes may play an even greater role in determining the financial performance of the agricultural industry. Therefore, it is becoming

increasingly important that farmers and agribusinesses understand the linkages between the macro economy and agriculture in making sound business decisions.

Crowding out occurs when expansionary fiscal policy causes interest rates to rise, thereby reducing private spending, particularly investment. The extent of crowding out is greater the more the interest rate increases when government spending rises. Monetary Policy is accommodating (Dornbush,p.283) when, in the course of fiscal expansion, money supply is increased in order to prevent interest rate from increasing. Monetary accommodation is also referred to as monetizing budget deficits, meaning that the Reserve Bank prints money to buy bonds with which the government pays for its deficit. When the RBI accommodates a fiscal expansion, both the textbook IS and the LM schedules shift to the right. Output will clearly increase, but interest rates need not rise. Accordingly, there need not be any adverse effects on investment.

Given the decision to expand aggregate demand (Dornbush, pp. 287-8), who should get the primary benefit? Should the expansion take place through a decline in interest rates and increased investment spending, or should it take place through a cut in taxes and increased personal spending, or should it take the form of an increase in the size of government. Conservatives will argue for a tax cut anytime. They will favor stabilization policies that cut taxes in a recession and cut government spending in a boom. The counterpart view belongs to those who believe that there is a broad scope for government spending on education, the environment, job training and rehabilitation, and the like, and who, accordingly, favor expansionary policies in the form of increased government spending and higher taxes to curb a boom. Growth minded people and the construction lobby argue for expansionary policies that operate through low interest rates or investment subsidies. Recognition that monetary and fiscal policy changes have different effects on the composition of output is important. It suggests that policy makers can choose a policy mix-a combination of monetary and fiscal policies.

Monetary and Fiscal Policy and its Effect on Agriculture

Does monetary policy at the national level have an influence on farm credit programs, does fiscal irresponsibility outside agriculture lead to budget excesses in agriculture, so should fiscal overspending outside agriculture be the target variable to be controlled? The impact which macroeconomic policies have on the nature and range of agricultural policy options is well documented in American and international literature. This relates with Monetary Policy, Fiscal Policy, Exchange Rates, etc. However in India studies have been few and have concentrated on the impact which agricultural policy making may have on the other sectors in the economy and the country's macroeconomic balance. These studies consider the ways in which in India agricultural policies impinge on the rest of the economy and consider implications for the design of economic policy. Let us however begin with the American literature.

Modelling the Effects of Monetary Shocks.

Belongia (85, Revised, 87) concludes that a considerable literature has developed on the response of the farm/non-farm price ratio to monetary shocks. "Testing alternative theoretical models with a consistent data set, however, uniformly rejected the notion that farm prices overshoot their long-run equilibrium values or that input prices paid by farmers rise faster than farm-product prices, creating a "cost-price squeeze" The only theoretical argument consistent with the data and estimated relationships for the US is that the supply of farm products is more inelastic in the short run than the supply of non-farm products. Under these conditions a given shock to aggregate demand will cause prices for the good with the more inelastic supply function to rise."(ibid, page 18)

Regardless of the direction of relative price change however, the adjustment process does not appear to be a protracted event that requires a cushion in the form of current farm programs. Qualitatively the results indicate that changes in monetary policy are not likely to be a source of large or long-lived disturbances to the farm-nonfarm price ratio. However in countries like India this may not hold and there may be structural reasons for terms of trade or farm-non farm ratios to change with different economic policies (Munish Alagh,2011, Ch.3 and 4).

Modeling the Effects of Fiscal Irresponsibility on Agriculture

A primary purpose of a paper by Chambers and Just(87) is to demonstrate that, under plausible circumstances, fiscal irresponsibility in the nonagricultural sector of the economy can lead to increased spending on farm programs when target prices are fixed in nominal terms. The chain of reasoning is simple. Overspending in the nonagricultural sector of the economy raises a deficit that must be financed and financing the deficit requires higher interest rates and exchange rates both of which depress prices for exportable agricultural commodities. Falling market prices thus cause higher deficiency payments (an American policy) and probably higher expenditures on farm programs because of fixed target prices. A natural corollary to this proposition is that the place to attack budget excesses in agriculture might be outside of agriculture rather than in instituting drastic supply control policies which may help the budget but ultimately damage long-run competitiveness in world markets. This analysis Chambers and Just (87) assumes that the budget is intertemporally constrained so that any current flow deficit must be made up in a later period. This is done using a three period model where the case of a flow deficit in the first period is compared to the case of a period-by-period balanced budget. Relatively more spending in the first period than in the balanced budget case is referred to as "overspending" or "fiscal irresponsibility."

Conceptually, for example, the first period corresponds to the 1991-2004 period in India during which deficits were high. The second period represents the remainder of the 2000-2010 decade during which actions to repay some of the cumulative budget deficit were necessary. Analytically these necessary future adjustments are integrated into the model by requiring an intertemporally balanced budget. In other words, the analysis constrains the ending cumulative deficit level. Specifically, the intertemporal budget constraint is

$B_t=0, t=1,2$, given by $t=1=1991-2004$, $t=2=2004-2010$

$$G_t = \hat{G}(M_t, r_t, s_{2t}, \bar{B}_t)$$

G_t is government expenditure in time period t .

s_{it} is the producer price in sector i at time t ,

r_t is the current interest rate.

M_t is the money supply

\bar{B}_t is the preexisting cumulative government deficit in period t

Government expenditures required to balance the current budget depends on the preexisting government deficit, the money supply which determines interest and exchange rates, government revenues raised by the income tax, and expenditures on agricultural subsidies. Because the government possesses several instruments for controlling the deficit, the following three possibilities can be examined for next-period adjustment:

- (a) A reduction in government spending
- (b) An increase in the money supply and
- (c) An increase in the tax rate.

Benign Outcomes

Fiscal and Monetary Policy can also play a output and productivity enhancing role. In the discussion on crowding out of investment above (Dornbusch, 2004), public investment can also play a crowding in role of investment in the agricultural sector. Errol De Souza (Errol De Souza, 2011) has also outlined conditions in which government expenditures can play an output enhancing and productivity expansion role. We state the conditions below.

In times of recession deficit financing helps to boost aggregate demand and to reduce unemployment when agents respond slowly to information that enables them to update expectations or when wages or prices are rigid. Aggregate expenditures that result from the debt financing of the deficit can affect the growth rate of the aggregate output of the economy.

In national accounts, government expenditure is the sum of consumption and investment expenditure. The link between government expenditures and macroeconomic outcomes when government spending includes public investment also needs working out. Government expenditures on roads, ports, railways, airports, power, irrigation projects and canals, and on public education and health improves the productivity of private factors of production. When the productivity of agriculture improves due to such public investments, agricultural farms are able to produce more output per unit of input. This results in an upward shift of the production function. In turn this results in a shift outwards of the aggregate supply curve for agriculture.

If some portion of the additional government spending be public investment expenditure that enhances the productivity of business enterprises, there are two impacts of the increase in public investment expenditure that we must consider:

- On the supply side the increase in public investment improves the productivity of business enterprises and increases the potential output of the economy with a rightward shift of the AS (aggregate Supply) curve.
- On the demand side the deficit financed increase in public expenditure shifts the standard IS curve rightward and the aggregate demand curve corresponding to IS is then shifted to the right.

Some private investment and consumption expenditure will have been crowded out due to the rise in the interest rate resulting from this expansionary fiscal policy as in the case of pure government consumption expenditure. The reduction in the stock of private capital as private investment is adversely affected reduces the potential capacity of the output of the economy and will shift the AS curve leftwards. This is because public investment has crowded out and substituted some private investment through raising the cost of capital.

If, however, public investment is complementary to private investment, then, the increase in public investment by virtue of increasing the productivity of private firms induces them to

increase their investment expenditure. According to De Souza, the empirical evidence for India is that public investment is complementary to and crowds in private investment. An increase in productivity also increases the marginal product of capital, and induces greater private investment. This will cause the IS curve to shift further to the right.

Let us suppose that the increase in productivity and the increase in the wage rate and incomes from the increased public investment in agriculture induces an increase in interest sensitive private expenditures in agriculture. If this occurs in the net there will be no decline in private investment spending and consequently no decline in the stock of private capital. The leftward shift of the AS curve due to crowding out will be exactly offset by a rightward shift of the AS curve due to crowding in. The general conclusion, however, can be stated in two parts:

- (1) As long as the decline in private investment is smaller than the increase in public investment and the marginal product of public capital equals the marginal product of private capital the potential output of the economy as given by the AS curve shifts to the right.
- (2) If the decline in private investment is larger than the increase in public investment but the marginal product of public capital is sufficiently larger than the marginal product of private capital, the potential output of the economy as given by the AS curve still shifts to the right.

The composition of government expenditures is therefore important to the macroeconomic outcome of a deficit financed increase in public expenditure. Debt financed government expenditure is not necessarily a burden on the economy in the sense of crowding out private investment and reducing the potential output producing capacity of the economy. To the extent that the financing of the deficit is for public investment expenditure there are two avenues through which this impacts favorably on agriculture. First, the increase in public investment improves the productivity of agriculture and induces or crowds in private investment spending that offsets some of the crowding out caused by the deficit financing. Second, the increased public investment adds to the public capital stock and this independently of the effect on private

investment enlarges the potential output of the economy. A government may then run a deficit and not harm long run economic performance if it devotes a sufficiently large part of its expenditure to public investment and infrastructure spending. The conclusion that deficit financing is associated with crowding out is tempered to the extent that public expenditure is public investment expenditure that improves the productivity and enhances the output of the economy.

These are obviously empirically testable propositions.

Indian and Global Literature on Agriculture's Interaction with the Economy

India does not have a very rich tradition of such studies. The theme of an early substantive economy level study of Indian agriculture by Servaas Storm (S.Storm, 1992) for example is that, in large low income economies having a large agricultural sector such as the Indian, an unsatisfactory rate of agricultural growth may act as a major constraint by limiting the possibilities of non-inflationary industrial expansion in a variety of ways. Storm discusses that shortfalls in food availability may lead to price rises which erode investible surpluses, the slow growth in agricultural inputs used in manufacturing can limit the growth rate of certain key sectors and most important, the slow rise in agricultural productivity can lead to a deficiency in (domestic) demand for industrial products. It is in these circumstances that the formulation of agricultural policy acquires an economy wide importance and that one is likely to require a general equilibrium framework, such as the one developed in his study (and other studies such as De Janvry and Subba Rao, (1986), Sarkar and Subba Rao(1981), Taylor(1983), Taylor, Sarkar and Rattso(1984), Sarkar and Panda(1991), Narayana, Parikh and Srinivasan(1987,1991), Mitra and Tendulkar(1986)) to satisfactorily analyze the direct and indirect effects of agricultural policy changes.

The purpose of our study however is to assess whether and if so, to what extent, in India, agriculture is affected by the rest of the economy, this is different from studies like Storm's which determine how the rest of the economy is affected by the performance of the agricultural

sector. However both these studies share a common objective. What are the major interrelationships between agriculture and the rest of the economy?

Alternative Theories of Agriculture-Industry Interaction

By transferring relatively low-productivity labor from agriculture to non-agriculture which is assumed to have a higher level of labor productivity, an important slack in the economy can be taken up. This was first pointed out by W.Arthur Lewis(1954) in a well known model of a two sector economy. Adopting the special case of the Lewis model where the industrial labor force is dependent on the marketed surplus of food crops from domestic agriculture for its subsistence, Chakravarty (1974) argued that, in India, the increasing excess demand for food grains started to pull the inter sectoral terms of trade in favor of agriculture from the mid-sixties onwards. This shift of terms of trade forced up the industrial product wage. Based on a time series of the income terms of trade constructed by Thamarajakshi (1969), Chakravarty argued that the shifting terms of trade have resulted in net income transfers to the agricultural sector. Assuming that savings rate is lower in agriculture than in industry, this transfer of income resulted in a decline in the aggregate rates of saving and investment and, consequently a slowdown of the overall growth rate of the Indian economy.

Formal presentations of Lewis's work started with Gustav Ranis and John C.H.Fei(1961)whose model has two turning points-when food supply begins to decline as labor is withdrawn from agriculture and when the marginal product of agricultural labor rises to the institutionally fixed non-agricultural wage rate.

An example considered in Storm concerns India during 1951-52 to 1970-71.Estimates by Mundle(1981)show that, since 1955-56, agriculture's net finance contribution in real terms has been positive and relatively large in terms of agricultural value added, but as a proportion of the value added in non agriculture, it reached a peak of only around 9 percent during the early 1960s after which it declined to only 3% in 1970-71.

In more recent contributions, there has been a discussion, for example of large capital inflows into India on private account and their impact on Indian agriculture. Have huge inflows of

speculative capital in the post-reform period affected the role of development institutions and banks like the National Bank for Agriculture and Rural Development, the apex bank for institutional credit in rural India? In order to prevent a possible appreciation of the currency, which would have had an adverse effect on the real sector of the economy, the Reserve Bank of India resorted to market intervention and the increase in the foreign exchange reserves, which would have caused a possible increase, in the money supply, was neutralized by undertaking a “sterilization” process. In the process the RBI suffered a huge loss in its potential income and had to resort to a smaller transfer of funds to Nabard. On the other hand, Nabard, faced with an increasing demand for loans turned to open market borrowings at a higher interest rate, which ultimately led to a huge loss in its potential income. A study (Sauvik Chakravarty, Zico Dasgupta, 2010) suggests that with the ongoing reforms, the banking system has not only sacrificed developmental aspects, but also failed to satisfy the profit norms of banking

Macro Questions Relating to Indian Agriculture

Literature review and an intuitive feel of The Indian economy suggest that systematic analysis of the impact of macro policies and variables on the agricultural economy can be a rewarding field of study. This is particularly so on account of a number of reasons. First the economy is growing faster and Indian agriculture will be demand driven. Second the economy is increasingly marketized and now open to global trade impacts. Third while the reform process in Indian agriculture is slow many quantitative interventions directly in agriculture have been reduced or eliminated. Alternatively there are no larger macro principles specific to agriculture which drive them.

We illustrate the main lessons of this paper by demonstrating the relevance of the approach in a macro economic partial equilibrium framework of an important agricultural outcome. If expansionary/ contractionary macro policy (Monetary-Fiscal policy mix) leads to rise/fall in money income, it will impact significantly on agricultural demand. Does this then lead to fluctuations in agricultural supply? There are many ways to analyze this kind of question. We will use a partial economy framework using lags to help the specifications of our model (L.R.Klein, 1962).

Modelling the Relation between Agricultural Prices and Supply

To get back to our macro story, in the short run in a closed economy with supplies given an increase in demand will increase agricultural prices. The interesting question then is will agricultural supplies increase as a response to prices. This question was raised and answered by Pulapre Balakrishnan for the foodgrain sector for the period 1950/51 to 1979/80 (P. Balakrishnan, 1991) and since then by Munish Alagh (Munish Alagh, 2011). Balakrishnan uses the following model (P.Balakrishnan,1991,p.78):

$$A = a(RP^e, t)$$

$$Y = y(W, I, F, t)$$

$$Q = AY$$

Here A is acreage under foodgrains, Y is yield, Q is output, RP is the relative price of foodgrain, W is a weather variable, I and F are input variables and t is a time trend. RP is the ratio of foodgrain prices to manufacturing prices and therefore corresponds to the farm/ non farm price ratio discussed in the literature review above. He states ‘since the assumption of ‘adaptive expectations so completely dominates the early Nerlovian literature on supply response, I shall also estimate the acreage equation incorporating this assumption.’”(P. Balakrishnan,1991,p.85)

We will return to his Nerlovian framework later but P. Balakrishnan’s empirical work ends with the conclusion “that at an aggregative level, the foodgrain sector in the Indian economy is not highly responsive to relative price shifts as far as the area cultivated is concerned.”(P. Balakrishnan,1991,p.87)

Given this background (P.Balakrishnan is one of many authors with similar conclusions: see M.Alagh,2011, Ch.1,for an extensive literature review) we make an attempt to answer the question: Is Indian Agriculture moving to a market determined economy? We show that in the last quarter century as the economy grew faster and liberalized, the non foodgrain sector of Indian agriculture responded to price signals in a decisive manner. This was true for food crops like oilseeds and sugar and commercial crops like cotton, tobacco and jute and mesta. Farmers

allocated resources not only to these crops, responding to price signals, which has always been known but to the non foodgrains sector as a whole, which was earlier disputed.

In the context of the wider developments in the Indian economy, which we have analyzed elsewhere (M.Alagh,2011,ch.3), and state but do not review here, we postulate that:

a) price responsiveness does not determine supply expansion (as in Pulapre Balakrishnan, 1991, above) in the first traditional phase of Indian agriculture after Independence (the period 1950/1980) and that in this phase the main drivers of growth were area and technology;

b) in the period since then (1980 through the nineties), price incentives determine the aggregate effort the farmer puts in the agricultural system, for those aspects of the economy in which price incentives are allowed to function and in this context the application by the farmer, from the choices available to him of technology determines the supply outcomes.

We now test the postulate (b) above. This is based on the hypothesis framework of an autonomous policy regime that price signals activate a supply response in that part of the agricultural economy, which is allowed to adjust to price stimuli in a competitive economy. We postulate this is the non-food grain segment of the agricultural economy. It may be recalled that at the crop level price responsiveness has been estimated as statistically significant by various scholars. Our hypothesis is more general. It is that in a significant section of the agricultural economy, price signals determine supply response. Does this mean that the agricultural economy is now price responsive as a whole? This is a difficult question to answer in a transitional policy regime (Mungekar, 1992; 1993). Most certainly the price responsive economy is growing faster. Whether it is on account of resource diversion or resource augmentation needs are to be examined more closely. But first the results may be seen. Terms of Trade data are taken from two sources. The first is the implied price deflators in *National Account Statistics*, published by the Central Statistical Organisation. Gross Value of Output in the Agricultural Sector at current prices divided by the Gross Value of output in the Agricultural Sector at constant prices gives the price deflator for the agricultural sector. A similar procedure gives estimates for the non-agricultural sector. The ratio of the two estimates of price deflators gives the terms of trade for

the agricultural sector (TOTn) or the farm non farm price ratio.. The other source of this variable is the Reports of the Commission on Agricultural Costs and Prices, which prepares and publishes the Index of Terms of Trade between the Agricultural and Non- Agricultural Sectors (TOTc). There is a problem in constructing a relative price variable for the non-food grain sector to test the stated hypothesis. In fact it has been argued that using crude relative variables in a two sector economy can lead to substantial specification errors (CSO, 1984: Appendix VII). Economic analysis can suggest a way out. It can be reasonably argued that the economic environment for a farmer is broadly the same, whether he grows food grains or non-food grains. It is just that the actual stimuli he receives will depend on the intervention of the Government also. If this interpretation is correct then the economy level terms of trade or relative price variable will determine the acreage choice for those segments of the economy where the farmer operates in a market environment. In our notation this would imply that the N variable (Non Foodgrain Sector) will be determined by the TOT variables. Before testing this hypothesis we decided to see if there was general congruence between different price variables affecting the agricultural sector. If Pf is the price of food grains variable, its relation with Pn could be examined. This was done in an earlier published work by the author (M.Alagh, 2004). The results were as follows (sample from 1980-81 to 1993-94 was taken for testing):

$$(1) P_n = 0.07 + 0.94 P_f$$

$$(0.06) (0.04)$$

$$R^2 = 0.98 \text{ d.f.} = 12$$

Therefore, like many price series, the two prices move together. We also examined the relation between Pn and the aggregate price deflator for the agricultural sector as a whole. We defined this as Pa which is the price level of prices received by the agricultural sector as a whole. The relationship was seen to be as follows:

$$(2) P_n = -0.03 + 1.03 P_a$$

$$(0.03) (0.02)$$

$R^2=0.99$ d.f.=12

While prices tend to move together on account of macro relations, say with money supply, we consider this result an endorsement of the analytical position that the non-food grain sector is operating in an overall economic environment, which needs macro level analysis. It is to this that we now turn. The acreage response relations that we have been discussing above are now estimated for the non-food grains sector but postulating that for resource allocation to that sector the farmer operates in the macro economy for the agricultural sector as a whole, in other words he responds to the agricultural terms of trade or the farm/non farm ratio.

If N_t = Acreage under non foodgrain crops, the subscript n also to the sector and t represents the time variable:

The estimates are reported as follows:

$$(3) N_t = -55.66 + 177.03 \text{ TOT}_t$$

$$(24.26) (23.91)$$

$$R^2 = 0.71 \text{ d.f.} = 21$$

$$DW = 0.82 \text{ Adj-}R^2 = 0.61$$

Figures in brackets are standard errors and DW is the Durbin Watson statistic..

The period is 1981-82 to 2003-04. Terms of trade determine acreage response in the non-food grains sector. The dL value at 0.01 and 0.015 levels are 0.98 and 0.74 and so with an estimated value of the d statistic of 0.82 the inference on serial correlation is inconclusive in this variant of the estimate.

A log linear version of (3) is as follows:

$$(4) \log N_t = \log 26.49 + 4.56 \text{ TOT}_t$$

$$(0.21) (0.21)$$

$$R^2 = 0.71 \text{ d.f.} = 21$$

$$D.W. = 0.83 \text{ Adj-}R^2 = 0.61$$

In a log lin regression elasticity b is multiplied by X. If the TOT is 1 or terms of trade are in parity, the elasticity of acreage response in Equation 4 is 4.56. This is high. The evidence on serial correlation is as in the last equation, inconclusive. There is evidence that the Indian farmer responds to a favorable environment for the market determined sector of the agricultural economy.

The double log version of this equation is as follows:

$$(5) \log N_t = \log 4.58 - \log 0.35 \text{TOT}_t$$

$$(0.86) (0.51)$$

$$R^2 = 0.43 \text{ d.f.} = 22$$

$$DW = 1.67 \text{ Adj } R^2 = 0.41$$

The regression is not significant but there is no serial correlation.

We now estimate the lagged specification of (3), (4) and (5). The results are as follows:

$$(6) N_t = -49.85 + 172.37 \text{TOT}_{t-1}$$

$$(26.33) (26.81)$$

$$R^2 = 0.67 \text{ d.f.} = 20$$

$$DW = 0.43 \text{ Adj-}R^2 = 0.48$$

$$(7) \log N_t = \log 27.80425 + 4.389 \text{TOT}_{t-1}$$

$$(0.23) (0.23)$$

$$R^2 = 0.67 \text{ d.f.} = 20$$

$$DW=0.62 \text{ Adj- } R^2 = 0.47$$

The acreage response function is highly elastic to lagged prices with an elasticity of around 4.4 and the relationship is significant. But there is serial correlation.

The double log version is as follows:

$$(8) \log N_t = \log 4.79 + 1.35 \log TOT_{t-1}$$

$$(0.02) (0.39)$$

$$R^2 = 0.50 \text{ d.f.} = 22$$

$$DW=0.62 \text{ Adj } R^2=0.47$$

The regression is significant, the elasticity of 1.35 is acceptable.

We note that if a recursive system as a cobweb is specified say in two equations, “The first equation may be estimated consistently by OLS.” And again, “Thus an OLS regression of y_2 on y_1 and x will yield consistent estimates of the second structural equation.” (Johnston, 1984: 468). Thus the problem of serial correlation can be solved in the OLS structure by proper specification and data selection. It is obvious that if acreage in the current year depends on prices received in the last year, regressions of this year’s prices on acreage will give incorrect results with serial correlation in the error terms. To quote a standard text’s discussion of autocorrelation, in a “Cobweb Phenomenon”:

“if the farmers overproduce in year t , they are likely to reduce their production in $t+1$, and so on, leading to a Cobweb pattern” (D.Gujarati, 1995, p.404). In this particular case as Klein and Wold have shown OLS regressions will work as the following section shows.

These kind of systems are also associated with causal chain analysis as pioneered by Herman Wold (H.Wold,1953). The two crucial features of a recursive system are a triangular B matrix and a diagonal Σ matrix. As an illustration consider the model

$$y_{1t} + d_{11}X_t = u_{1t}$$

$$b_{21}y_{1t} + y_{2t} + d_{21}X_t = u_{2t}$$

with the specification

$$E(uu') = \Sigma = \begin{bmatrix} \sigma_{11} & 0 \\ 0 & \sigma_{22} \end{bmatrix}$$

To explore the connection between the y 's and the u 's we look at the reduced-form equations which are

$$y_{1t} = -d_{11}x_t + u_{1t}$$

$$y_{2t} = (b_{21}d_{11} - d_{21})x_t + (u_{2t} - b_{21}u_{1t})$$

The first equation is the same in each case. Since the exogenous variable x is by assumption uncorrelated with the u 's, the first equation may be estimated consistently by OLS. The second reduced-form equation shows y_{2t} , to be a function of both u_{1t} and u_{2t} . Thus it would be inappropriate to estimate the second structural equation by an OLS regression of y_2 on y_1 and x . However, y_{1t} is uncorrelated with u_{2t} , since it is a function only of u_{1t} which has zero correlation with u_{2t} . Thus an OLS regression of y_2 on y_1 and x will yield consistent estimates of the second structural equation.

In the usual analysis, current prices are related to current production. But both price and production may be measured as deviations from their respective time trends. "Lagged output" now will show how current output is related to past prices. Specifically, output here is lagged one period after price. If output in the first period is q_1 , price is p_1 . This leads to an output of q_2 and a price p_2 in the second period and so on.

Any model is recursive if it shows how certain initial conditions will affect conditions in a coming period say t_{+1} , then how conditions in period t_{+2} and so on. The Cobweb model is the simplest recursive model in economics, but it is not the only recursive model.

To reemphasize, “the first equation may be estimated consistently by OLS.” And again “Thus an OLS regression of y_2 on y_1 and x will yield consistent estimates of the second structural equation.” (J. Johnston, 1984, p. 468).

In an alternate estimate we directly estimated the supply equation which is as follows:

$$(9) \text{ Qnt/Ant} = 42.21 + 251.78 \text{TOTct} + 0.55 \text{F/Ant} - 32.68 \text{I/Ant}$$

$$(27.29) \quad (166.38) \quad (4.26) \quad (27.29)$$

$$R^2 = 0.93 \text{ d.f.} = 11 (81-82 \text{ to } 93-94)$$

The additional variables are

Q=Gross output at constant prices; F=Fertiliser use in nitrogen equivalent tonnes; I=Gross irrigated area.

The regression is significant but none of the variables are, on account of multicollinearity. It may be noted that a similar result was obtained by Pulapre Balakrishnan, 1991, pp.87-89). Therefore we get back to the causal chain reasoning. So from equation 8 the elasticity is taken as 1.35.

Does the Macro Economy Matter?

From this detour of pure acreage analysis lets get back to the motivation of this paper, namely testing if the macro economy matters. It is obvious that the number of rich hypothesis the literature review has thrown up will be worked on subsequently. But the question of the farm nonfarm price ratio as determined by macro features came up consistently and is a central issue. Also Purapre Balakrishnan has an erudite refutation of the farm non farm price ratio determining agricultural supplies for an early period. We have shown that the picture changes for the period since 1980. Prices and in turn the macro factors which drive them matter. Can these results be

used to argue that we can use them for forecasting purposes in the remaining part of this decade, the analysis of which will be critical for policy say in the Twelfth Plan (See, M.Alagh, 2011). We use our results and the causal chain system to do a forecasting exercise.

This forecasting exercise could be based on a supply equation with inputs and relative prices (farm-non-farm) as variables. But as we saw equation 9 suffers from multicollinearity and this is usual in such time series estimates. Balkrishnan also reports similar results. As noted one of the better methods of handling multicollinearity is improved specification of the equation systems (Gujarati, 1995: 340). As standard texts bring out dropping variables is not. For example, in the instant case dropping of either fertilizer or irrigation, strongly correlated with each other would be mis-specification. A recursive system, which we had detailed above is a better specification, and therefore, takes care of the causality problem.

Supply (S_t) in any period would equal acreage in the period multiplied by yield in the period (as in Purapre Balakrishnan's model. Therefore,

$$\log S_t = \log A_t + \log Y_t$$

but

$$A_t = a + b P_{t-1}$$

where P is a relative price, terms of trade or farm-non-farm price variable. The logarithmic or log lin estimate for this will be

$$\log A_t = \log a + b \log P_{t-1}$$

$$\text{or } \log A_t = a + b P_{t-1}$$

and yield will be estimated as

$$\log Y_t = a + b t$$

This model will be a causal chain model of the type described above.

It is obvious that if we ignore the errors specification, for in our case there is no reason for productivity to be correlated with acreage response, and treat this as an exactly specified model, acreage could be estimated from the first equation, plugged into the second equation and together with a trend yield equation, supply can be projected.

The Forecasting Exercise

We use the variant where the period upto 2003-04 is used for building estimates (Equation 8), and therefore the period 2004- 2009 is used for the forecast period. For estimating acreage in the forecast period from the log equation first the TOT variable is as estimated for the period 2004-05- to 2008-09. These estimates are as follows:

<u>TOT</u>	<u>Variable</u>
Year	TOT
2004/05	1.00
2005/06	1.05
2006/07	1.06
2007/08	1.11
2008/09	1.13

Source-NAS 2010, CSO

The % change in TOT is estimated by calculating $[(TOT_t - TOT_{t+1}) / (TOT_t + TOT_{t+1})] \times 100$

<u>Year</u>	<u>% change</u>
2004/05	4.46
2005/06	1.55
2006/07	4.00
2007/08	1.94

The Forecast % change in N or Non Foodgrain acreage in period t_{+1} is estimated by calculating % change in TOT multiplied by the acreage price elasticity(1.35) in the log linear equation:

<u>Year</u>	<u>%ChangeAcreage</u>
2004/05	Base
2005/06	6.02
2006/07	2.10
2007/08	5.39
2008/09	2.62

Next year's acreage can now be forecasted by adding the estimated percentage change to this years acreage.

<u>Year</u>	<u>Acreage*</u>	<u>Acreage forecasted</u>
2004/05	137.9	Base
2005/06	140.9	146.02
2006/07	143.0	143.03
2007/08	144.7	150.77
2008/09	147.8	148.76

***Source:**Economic Survey, 2011,

For estimating acreage from the linear equation in equation 7, first to estimate the elasticity, the slope of the independent variable or b value is divided by the average value of acreage divided by average value of TOT in the equation. We get an elasticity estimate of 1.47. Then the steps above are repeated to get the forecast acreage under non foodgrains.

Linear Model AcreageYear forecast

2004/05 Base

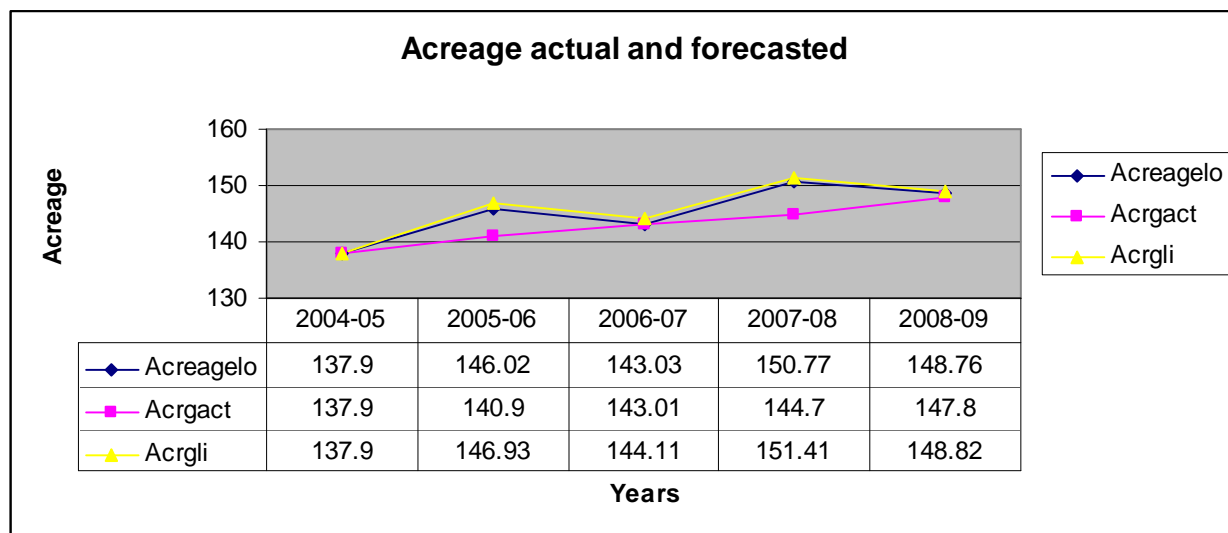
2005/06 146.93

2006/07 144.11

2007/08 151.41

2008/09 148.82

The table and graph below gives a comparative picture for forecast estimates of acreage using the log model (Acreagelo). Acreageli estimates are derived using the linear model and Acreageact is the actual acreage.



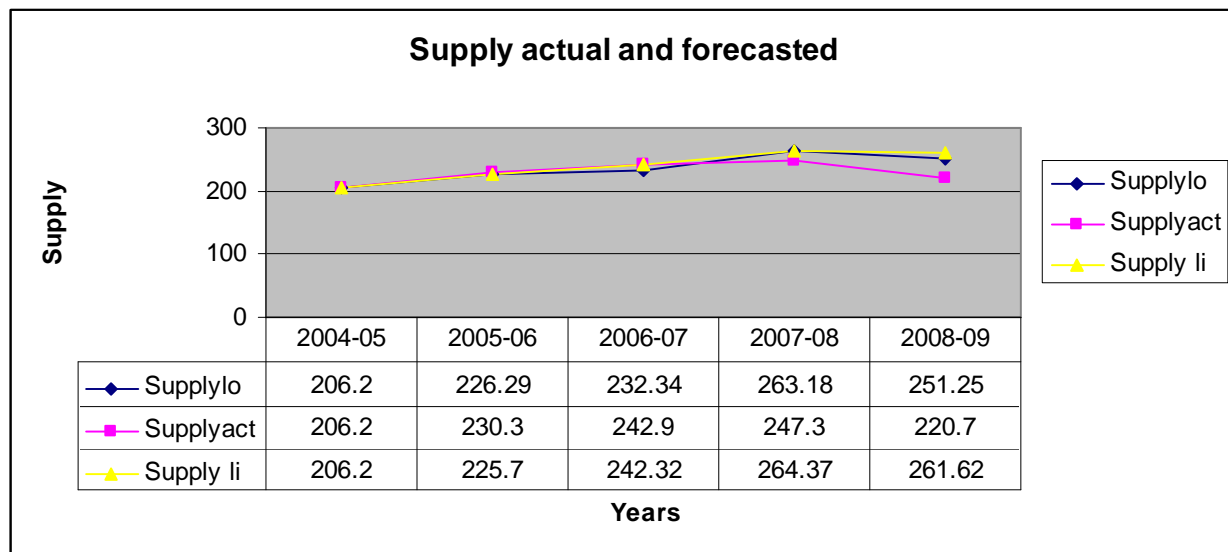
***Source-**Economic Survey, 2011, Statistical Tables

Both the linear and log models predict the acreage under non foodgrain crops reasonably well in 2006/07 and 2008/09. They predict the direction of change correctly in 2005/06 and 2007/08. They predict the upswing or the direction of the cycle in non foodgrain acreage correctly in 2005/06 and 2007/08. But they do not predict the numbers precisely. Both tend to

overestimate the change. It should be possible with further work to narrow down the estimated swing.

The yield of non-food grains is estimated from the index numbers of yield using the annual yield growth rate equaling 2.94% from 94-95 to 2007-08.

We add the acreage to growth rate with the yield growth rate to get supply to growth rate and hence forecasted values as



***Source**-Economic Survey, 2011, Statistical Tables

The logathmic model predicts fairly accurately in 2005/06(error around 2%) and 2006/07(error around 4%). The direction of change is accurately predicted in each year. In other words the cycle of non foodgrain output change with high price stability consequences can be anticipated. The linear model predicts the numbers closely in 05/06 and 06.07. It again predicts the direction of change correctly in each year.

Conclusion

This paper focuses on macroeconomic linkages with agriculture. We differentiate between alternative ways of looking at Indian agriculture. The question that emerges is: is there a structural constraint in Indian agriculture or does Indian agriculture work in a system in which as

demand rises and prices rise, supply responds. The constraints maybe institutional or policy determined in the foodgrains part of the economy, with the non foodgrain economy being responsive to market and non price factors mattering particularly in that part of agriculture not responding to prices.

These kind of general hypotheses will require an analysis of macroeconomic policy particularly of trends and impacts of government expenditure and money supply. What are the impacts of such policies on agricultural prices and interest rates for agriculture? How do they impact on agricultural demand, supplies and investment? Do monetary shocks and budget deficits affect farm output and the farm-non farm price ratio? These kind of questions have gained urgency in recent discussions both of agricultural and macro policies.

In evaluating the impact of macroeconomic policy changes, the mix of monetary and fiscal policies has to be evaluated.

Does monetary policy at the national level have an influence on farm credit programs, does fiscal irresponsibility outside agriculture lead to budget excesses in agriculture, so should fiscal overspending outside agriculture be the target variable to be controlled? The impact which macroeconomic policies have on the nature and range of agricultural policy options is well documented in American and international literature.

Belongia (85, Revised, 87) concludes that a considerable literature has developed on the response of the farm/non-farm price ratio to monetary shocks. Qualitatively the results indicate that changes in monetary policy are not likely to be a source of large or long-lived disturbances to the farm-nonfarm price ratio.

A primary purpose of a paper by Chambers and Just(87) is to demonstrate that, under plausible circumstances, fiscal irresponsibility in the nonagricultural sector of the economy can lead to increased spending on farm programs when target prices are fixed in nominal terms.

Fiscal and Monetary Policy can also play a output and productivity enhancing role. In the discussion on crowding out of investment above (Dornbusch, 2004), public investment can also

play a crowding in role of investment in the agricultural sector. Errol De Souza (Errol De Souza, 2008) has also outlined conditions in which government expenditures can play an output enhancing and productivity expansion role. The general conclusion, however, can be stated in two parts:

- (1) As long as the decline in private investment is smaller than the increase in public investment and the marginal product of public capital equals the marginal product of private capital the potential output of the economy as given by the AS curve shifts to the right.
- (2) If the decline in private investment is larger than the increase in public investment but the marginal product of public capital is sufficiently larger than the marginal product of private capital, the potential output of the economy as given by the AS curve still shifts to the right.

We illustrate the main lessons of this paper by demonstrating the relevance of the approach in a macro economic partial equilibrium framework of an important agricultural outcome. If expansionary/ contractionary macro policy (Monetary-Fiscal policy mix) leads to rise/fall in money income, it will impact significantly on agricultural demand. Does this then lead to fluctuations in agricultural supply? There are many ways to analyze this kind of question. We will use a partial economy framework using lags to help the specifications of our model

It is obvious that the number of rich hypothesis the literature review has thrown up will be worked on subsequently. But the question of the farm nonfarm price ratio as determined by macro features came up consistently and is a central issue. Also Purapre Balakrishnan has an erudite refutation of the farm non farm price ratio determining agricultural supplies for an early period. We have shown that the picture changes for the period since 1980. Prices and in turn the macro factors which drive them matter. Can these results be used to argue that we can use them for forecasting purposes in the remaining part of this decade, the analysis of which will be critical for policy say in the Twelfth Plan (See, M.Alagh, 2011). We use our results and the causal chain system to do a forecasting exercise.

The forecasting model we have takes the actual acreage and output numbers in each year and predicts the next year. The model could have been used to give smooth forecasts for a number of years. But that is not the motivation since this is not a model of long term growth. It is intended to predict the consequences of macro policies on agricultural output in the sense in which the major studies in the literature review do (Belongia, Just and Chambers, etc.). What it says is that if the economy is contracted or expanded, that will have an impact on farm/non farm price ratios and in turn determine output in the next year given the lags in acreage response. It will be also possible in this structure to work out the farm-non farm price ratio with which food inflation is avoided in the next year.

Thus the directions of change are largely predicted correctly by the graphs. They also predict downturns and upswings or the direction of the cycle. In many years the numbers are close to the actuals. There is demonstration that macro policies impact agriculture in a significant manner. The work has possibilities for future policy simulations of macro policy impacts on agriculture

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