A. No. 366

Sources of instability in Natural Rubber price: An analysis in the post-reform phase

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Abstract

Price is a crucial variable influencing the investment decision of farmers. As 80 percent of farmers cultivating Natural Rubber (NR) are comprised of marginal and small category, volatile movements in NR price, though mild, would adversely effect on the staying capacity of farmers and therefore on their investment decisions in farming. Introduction of new economic policies in 1991 and the subsequent integration of domestic market with the international economy brought in volatility in the price movement of primary commodities than ever before. Market integration was sought to be achieved by removing non-tariff restrictions on external trade of NR and NR based products. Volatility being an inevitable outcome of market integration, stability in NR price, which the farmer enjoyed for the past several decades is now greatly undermined. Given the structure of NR holdings and the type of farmers in India, frequent and violent fluctuations in daily price movement of NR may leave adverse impact on NR supply. The present study analysed the stability/instability and the sources of instability in NR price during pre and post-liberalsation periods. In the pre-liberalisation period, supply side variable contributed to the volatility in NR price. It appears to be rather logical because the rate of growth in demand for NR derive from the rate of growth in gross domestic product, which has grown more or less at a constant rate until 1991-92. On the contrary, demand for NR became more volatile in the post-liberalisation period as part of it originated from the export market in the form of demand for rubber based manufactured products. As a result, demand side variable too contributed significantly to NR price instability in the post-liberalisation period. The contribution to NR price instability from supply side factor still remain robust resulting to a cumulative effect on price instability in the domestic market during the post-liberalisation phase. The macro economic implication of the finding is that the NR price formation is increasingly being shifted from domestic market to international market and, therefore, any change in the world economic scenario might leave profound impact on NR price in the domestic market in the post-liberalisation phase.

Keywords: Instability, liberalisation, market integration, Natural Rubber, structural break

Introduction

Price is a crucial variable influencing the investment decision of farmers. Response functions in agriculture modeled to measure the price elasticity of supply and acreage include current price as well as the normal price expected (Nerlove, 1958; Mitchell and Speaker, 1986). In a scenario of crops competing with one another for area, relative price of the crop in question too assumes significance (Narain, 1958). For annuals, length of the distributed lag in price expectation is often confined to the immediate previous year price whereas for perennial crops the lag lengths of previous year prices are distributed over a period and price expectation coefficients are obtained by averaging lagged price in the past.

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It has been reported that mild but frequent fluctuations in NR price in the 1960s and 1970s, was replaced by violent but less frequent fluctuations in the 1980s. (Lekshmi et al.,1996). The degree of volatility in NR price was found to have deepened in the post-liberalisation phase compared to the preceding period (Mohanakumar and Chandy, 2005). In an analysis of mean earning instability per hectare of land for ten major crops grown in Kerala for the period 1962 to 1985 was

found that Instability Index for NR ranked seventh (from top in descending order) during the period from 1962 to 1976. In the second phase from 1976 to 1985 earning instability of NR did further improve as the instability index moved down to 8th position (Kannan and Pushpangadan, 1990). However, studies on price instability of primary commodities have the following common shortcomings: (i) arbitrary periodisation; (ii) statistical explanation to instability variations, which are devoid of policy interventions; (iii) impact of price instability on investment in farming is often ignored in the analysis and, (iv) instability analysis takes nominal price and the effect of changes in real purchasing power of farm produce are often not taken into account. Given the setting, the present study makes an attempt to:

1. analyse the structural breaks, if any, and instability in the long run movement in NR price

2. identify important sources of instability in NR price in the pre and post-liberalisation phases.

Materials and Methods

Time series data on NR price were collected from Indian Rubber Statistics, Rubber Board. Comparable price statistics are available only from 1976 and, therefore, the period of analysis is confined to 1976 to 2007.

The estimation of the long term growth demands a perfect knowledge of the economy and the variables in question. Often than not, such breaks are identified arbitrarily based on certain presumptions or with the visual judgment or graphical presentation of data. However, such identified break points need not always be statistically valid. The presence or absence of a break in the long-run growth path of a variable can be scientifically detected employing OLS-based CUSUM test (Balakrishnan and Parameswaran, 2007). However, F test and the ordinary CUSUM are statistically not a valid proposition for a variable with the presence of trended repressors. In that case Cramer-Von Mises test statistic procedure is used. The test statistics takes the form:

$$F^{(T)} = \frac{1}{T}\left\{ 1/\hat{\sigma}\sqrt{T} \sum_{i=1}^{t} \hat{u}_i^{(T)} \right\} \hat{u}$$

Where û is the residual of the OLS regression of the full sample size T and ó is the standard error of the regression. The limiting distribution of the test statistic F under the null hypothesis of no structural break can be defined as follows:

$$F^T \xrightarrow{d} X \overset{st}{\leq} \int_0^1 B^2(Z)\,dz$$

where $\xrightarrow{d}$ shows convergence in distribution, $\overset{st}{\leq}$ is the stochastic dominance and $B^2(Z)$ is Brownian Bridge.

The null hypothesis of no break in the long term growth trend is rejected at á level of significance provided the value of test statistic crosses the critical value. However, the year of the break and its corresponding growth rates are not supplied by the test statistic. On having identified statistically the structural break in the long run growth movement of the variable, kinked exponential growth rate can be used to estimate the rate of growth in each sub-period. It is assumed in such growth models that the break took place exactly at the year in which the policy changes was occasioned. The kinked exponential function having number of kink extends to four, the equation takes the following for

$$
\begin{aligned}
ln\,y_t = {} & A + \hat{a}_1\,(d_1 t + d_2 k) + \hat{a}_2\,(d_2 t - d_2 K) + \hat{a}_3\,(d_3 t + d_3 k) \\
& + \hat{a}_4\,(d_3 t - d_3 K) + \hat{a}_5\,(d_3 t + d_4 K) + \hat{a}_6\,(d_4 t - d_4 K) \\
& + \hat{a}_7\,(d_4 t + d_5 K) + \hat{a}_8\,(d_5 t - d_5 K) + u_t
\end{aligned}
$$

where Y_t is the value of the various at time t, A is the constant; $\hat{a}_1$ is the growth rate for the period 1, and $\hat{a}_2$ is the growth rate for the period 2 and so on; K is the break point; d is dummy variable (1 and 0 as the case may be) and u_t is the stochastic error term.

The break years are statistically estimated using Bai and Pierre methodology and the number of breaks are estimated based on minimum Bayesian Information Criteria.

Results and Discussion

Theoretical implications of market integration and price volatility

At the outset, two concepts of price and profitability need to be clarified. Price is the monetary expression of the exchange value of a commodity and it is comprised of: (i) value of labour power expended in the production of the commodity, (ii) ground rent, and (iii) profit for the capital invested by the landlord (Marx, 1954). Profit is comprised of: (i) re-investible surplus available with farmers, and (ii) consumption component. The consumption component in profit includes a physical as well as a historically determined social cost of living. The physical component does not vary much across states or districts within a geographical entity while the socially determined and historically evolved cultural component of living is region specific and therefore it varies by time and space (Marx, 1954). On account of the achievements in social indicators of development and level of the development of the people in the geographical entity concerned, the social cost of farmers and workers in Kerala is one of the highest in India. In other words, for a given level of productivity, a uniform price for NR in India implies that the re-investible surplus available with

the farmers for recommitment in the production process in Kerala would be on a lower side when compared to the same in other relatively backward states. However, as more than 90% of the total production of NR is from Kerala, the NR price in India is formed on the basis of the social cost of production in Kerala. A uniform price in India exists for NR because the domestic market is totally integrated. Under an integrated international market for NR, price for a commodity vary only to the extent of transaction and transport costs and the basic price remain uniform across production units in the world. The policy of market integration, therefore, implies that the social and physical cost of living of farmers and labourers working in rubber plantations be made uniform and those above the uniform cost should quit the market or will incur a loss. The Rule of One Price under an integrated international market could be achieved by leveling down the trade restrictions imposed upon the commodity. Volatility in NR price in the post-liberalisation period and its likely consequences on social cost of reproduction of farmers and labourers on the one side and the re-investible surplus available with the farmers on the other may be viewed against this backdrop.

The price factor shifts the supply curve outward. It has been estimated that the supply response to weather and technology (non-price factor) is three times higher than the price factor (Kannan and Pushpangadan, 1988). The price factor on the supply side has a short-run as well as a long run effect. In the short run, as supply is inelastic to price change, a rise in the price of agricultural commodities would push up the real income of farmers and erodes the real income of labourers, which would in turn leave a relatively higher surplus with the farmers. Re-investment of the surplus in the farming sector increases days of employment and thereby push up the nominal income of labourers in the long run. However, if the rate of growth in the nominal wage rate is lower than the growth rate in output price, it would again take back the increase in income of labourers through an inflationary effect. The increase in output through productivity enhancement has two dimensions: (i) output increase with flexible price; and (ii) output increase with fixed price (Kannan and Pushpangadan, 1988). If output increases under a flexible price scenario, it may drive down the price level leading to an increase in real income of all classes in the society through employment and income effects. On the contrary, if output increases under a fixed price scenario, it may push up the real income of farmers while other sections in the society may suffer an erosion in their real income.

Structural breaks in NR price

Trends in NR price movement in the long run need statistical examination to delineate the differences between pre and post liberalisation phases. It may be noted that the trend in primary commodity prices in any two markets at a point of time may exhibit signs of synchronization even if the markets are not integrated. In the long run NR price movement in the domestic and international markets,. Three broad phases could be identified in the long run NR price movement in the domestic and international markets. In the first phase, domestic price of NR ruled below the international price and the phase extend upto mid 1970s. In the second phase, which commenced in 1978, Indian price grew faster and prevailed over the international price. The second phase continued upto early 1990s. Those two phases were charactersised by rigid control over the external trade of NR and NR based products in India. The third phase from 1992-93 onwards is characterized by frequent and violent ups and down, which is unprecedented in the price history of the crop. During that period, NR price movement in the domestic market moved in perfect harmony with international price and the price in the domestic market ruled below the international price. These three phases are shown in Fig. 1.
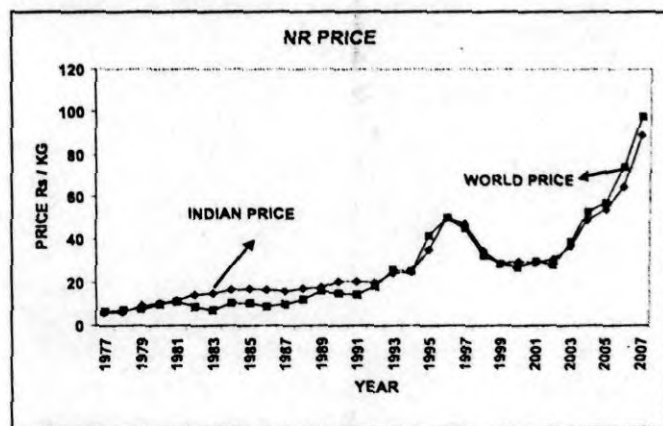

Fig. 1. NR price in the Indian and International Market

Characteristic features in the long run movement in NR price and its response to shift in policy paradigm needs to be delineated. The first step to this direction is the detection of structural breaks, if any, in the long run growth path of NR price. It is therefore worth examining whether the long run movement in NR price has experienced discontinuity and if so the extent of discontinuity in the pre and post-liberalisation phases.

Table 1 shows the structural breaks in the long run movement of NR price in the domestic and international market as well as the rates of growth in the corresponding break points. A comparison of the long

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term trends in the price of NR in the domestic and international market has revealed that there are five structural breaks in the long run movement during the period between 1976 and 2007. Statistical examination of the continuity / discontinuity in the long run movement in NR price has shown that three breaks have occurred in its growth path during the 17 year period between 1991 and 2007 while NR price has experienced only two breaks between 1976 and 1990.

Table 1. Structural breaks and rate of growth in NR price

Domestic Price		International Price	
Break period	Rate of growth (%)	Break period	Rate of growth (%)
1981(1976-81)	19.20	1980 (1976-80)	7.40
1989 (1982-89)	1.40	1989 (1981-89)	2.70
1994 (1990-94)	13.20	1994 (1990-94)	22.70
1999 (1995-99)	-2.40	1999 (1995-99)	-5.20
2000 (1999-2007)	11.40	2000 (1999-2007)	13.40

It is interesting to note that the trend in the rate of growth in NR price in the domestic market, to a certain extent, was comparable to the trends in price movement in the international market during the post-liberalisation phase (Table 1). In the domestic market, price of NR registered the highest rate of growth (19.20%) during the period between 1976 and 1981 whereas the maximum rate of growth (22.70%) in NR price in the international market was recorded during 1990-94 period. In the second half of 1990s, NR price dipped and the rate of growth turned negative in both domestic and international markets. Again, rate of growth in NR price pegged up in domestic and international markets during the period 1999-2007.

NR Price Instability

Comparable price data for NR is available only from 1976 and therefore, the price analysis is confined to 1976-2007 period. Estimated instability in NR price is presented in Table 2. It is clear that the price instability has increased significantly in the post-liberalisation period in the domestic as well as international markets. Table 2 also indicates the nature of convergence / divergence in NR price between the domestic and international markets under pre and post liberalisation periods. In the pre-liberalisation period, correlation coefficient of price residuals obtained from time trend regression for the domestic and international market was negative (-0.42). It shows that the domestic price for NR during 1976-1992 (pre-liberalisation) period was not influenced by the price movements in the international market. On the contrary, a perfect one to one correlation (1.00) could be observed in price residuals in post-liberalisation phase. It indicates a positive association in

NR price in the domestic and international markets during the post-liberalisation phase.

Table 2. Price instability coefficient of NR in domestic and international markets

Period	International	Domestic	Correlation of residuals
1976-1992	2.03	2.52	-0.15
1993-2007	9.11	7.07	1.00

Note: Instability is worked out with the equation: $\Sigma (X_t - ae^{bt})^2 / n$ where X_t is the actual value; ae^{bt} is the gross value of output per unit of land of the crop concerned with 'n' observations. It is a modified version of instability measure employed in Kannan and Pushpangdan (1990)

Sources of Instability

Instability can originate either from supply or from demand sides or from both. Implication of the origin of the instability is very important from a policy perspective. If price instability originates from the demand side, it is related to changes in macro economic variables and therefore price stabilization measures would not be effective unless macro economic variables are correct. Under the process of market integration, price instability is more likely to originate from demand side. Supply side instability originates mostly from two sources: (i) climate change; (ii) sudden change in expected price. However, possibility of such changes to cause persistent instability in NR price is rather limited particularly in the case of a perennial crop like NR.

Sources of instability can be identified by correlating the residuals obtained through univariate time trend regression equations of price, supply and demand variables. A high correlation equal to unity merits to be ranked as the first source of instability. Sources of instability are separately identified for pre-liberalisation and post-liberalisation phases. Table 3 presents the results for pre-liberalisation period (1976-1991). Important observations emerging from the Table 3 are: (i) correlation of residuals between price and production is positive and significant (0.665**). It indicates that price instability in the pre-liberalisation period did originate mostly from supply side (production of NR); (ii) NR consumption (-0.446) or demand side variable did not contribute to price instability in the pre-liberalisation period. Results presented in Table 4 shows the sources of NR price instability in the post-liberalisation period. Observations from Table 4 are : (i) a high correlation was found between the residuals of consumption and price (0.764**). It indicates that variations in the demand for NR has significantly contributed to the price instability in the post-liberalsiation period; (ii) correlation between production and price has strengthened in the post-liberalisation phase when compared to pre-liberalisation phase. It shows that the contribution of

supply side variable (NR production) to NR price instability has increased in the post-liberalisation period. Fluctuations in the demand for NR in the post liberalisation phase could add to the contribution of supply side variable in price instability.

Table 3. Correlation coefficient of residuals of NR variables: pre-liberalisation period

Variables	Consumption	Production	Area	Yield	Price
Consumption	1.00	0.395	-0.284	0.210	-0.446
Production	0.395	1.00	-0.346	0.838**	0.665**
Area	-0.284	-0.346	1.00	0.034	-0.299
Yield	0.210	0.838**	0.034	1.00	-0.738**
Price	-0.446	0.665**	-0.299	-0.738**	1.00

** Correlation is significant at the 0.01 level (2 tailed)

Table 4. Correlation coefficient of residuals of NR variables: post-liberalisation period

Variables	Consumption	Production	Area	Yield	Price
Consumption	1.00	.0.749**	0.391	0.749**	0.764**
Production	0.755**	1.00	0.782	0.973**	0.999**
Area	0.391	0.782**	1..00	0.782**	0.778**
Yield	0.749**	0.973**	0.814	1.00	0.972**
Price	0.764	0.999**	0.778	0.972**	1.00

** Correlation is significant at the 0.01 level (2 tailed)

Conclusion

Price for agricultural commodities is determined by the dominant producers of the crop. The value of a crop is fixed on the basis of the social cost of reproduction of the farmers and labourers engaged in the production of the commodity. The social cost of reproduction varies from regions to region. More than 90 percent of NR in India is produced in Kerala where average social cost of reproduction is one of the highest and, therefore, the cost of production and the price of NR need also be higher. Contrary to it, market integration rules out regional differences in social cost of production of NR. In the post-liberalisation period, NR price and its related variables from supply as well as demand sides behaved differently. Instability in NR price indicated that it became more volatile in the post-liberalisation period than the pre-liberalisation period. Further, NR price movement in the domestic market was not effected by the price changes in the international market in the pre-liberalsation period. Conversely, in the post-liberalisation phase, NR price in the domestic market moved closely in tandem with the price movement in the international market.

In the pre-liberalisation period, supply side variable contributed to the volatility in NR price. It appears to be rather logical because the rate of growth in demand for NR derive from the rate of growth in gross domestic product, which has grown more or less at a constant rate until 1991-92. On the contrary, demand for NR became more volatile in the post-liberalisation period as part of it originated from the export market in the form of demand for rubber based manufactured products. As a result, demand side variable too contributed significantly to NR price instability in the post-liberalisation period. The contribution to NR price instability from supply side factor still remain robust resulting to a cumulative effect on price instability in the domestic market during the post-liberalisation phase. The macro economic implication of the finding is that the NR price formation is increasingly being shifted from domestic market to international market and, therefore, any change in the world economic scenario might leave profound impact on NR price in the domestic market in the post-liberalisation phase.

References

Balakrishnan, P. and Prameswaran, P.2007. Understanding Economic Growth in India: A Prerequisite. *Economic and Political Weekly* 42 (27&28) :2915-2922.

Newbery, D.M.G. and Stiglitz, J.E. 1981. *The theory of commodity price stabilization: A study in the economic of risk.* 462 pp. Clarendon press. Oxford.

George, K. T., Joseph T., and Joseph, J. 2002. Natural rubber in post – QRs regime: *Economic and Political Weekly* 37 (32): 3319-3321.

Kannan, K.P. and K.Pushpangadan.1988. Agricultural stagnation in Kerala. An Exploratory analysis. *Economic and Political Weekly* 23 (39) : A-120-A-128.

Kannan, K.P. and K.Pushpangadan.1990. Dissecting Agricultural stagnation in Kerala. An analysis across Crops, Seasons and Regions. *Economic and Political Weekly* 25 (35) : 1991-2004.

Krishnakumar, A. K. and Jom Jacob. 2003. Rubber sector in the liberalised era: Developments in the NR Market in retrospect. *Indian Rubber Journal* 72: 64-69.

Lekshmi, S., Mohanakumar, S. and George, K. T. 1996.The trend and pattern of natural rubber price in India: an exploratory analysis. *Indian Journal of Natural Rubber Research* 9 (2) : 82-92.

Marx, K. 1954. *Capital, Vol. 1.* 767 pp. Progress publishers, Moscow:

Mitchell, D W and Speaker, P.J. 1986. A simple flexible distributed lag technique; The polynomial inverse lag. *Journal of Econometrics.* 31: 61-84.

Mohanakumar,S and Binny Chandy 2005. Impact of market uncertainty on investment and employment in rubber smallholdings sector: An analysis of trends in the post-reform phase. *Economic and Political Weekly* XL(46) : 4850-56.

Myres R.J. and Runge, C.F. 1985. The Relative contribution of supply and demand instability in the US Corn market. *North Central Journal of Agricultural Economics* 7(1) : 70-78.

Narain, Dharam (1977). Growth of productivity in Indian agriculture. *Indian Journal of Agricultural Economics* 32(1) : 1-44.

Nerlove, M 1958. *The dynamics of supply estimation of farmer's response to price.* 241 pp. John Hopkins Press, Baltimore.

Rubber Board 1996. *Indian Rubber Statistics.* Rubber Board, Kottayam 21 : 96