Chapter One

Introduction

Assam, popularly known as the land of the red river and blue hills, is the gateway to the north-eastern part of India. It is located between 90-96 degrees east and 24-28 degrees north. The present state of Assam is comprised of three physical divisions, namely, the Brahmaputra Valley, the Barak Valley and the Hilly Range. The Brahmaputra Valley, which forms northern part, is the largest comprising 71.7 per cent of total geographical area of the state. On the other hand the Barak Valley region, which forms the southern part, is comparatively smaller in size. The presence of mighty Brahmaputra River has transformed the land into a fertile zone.

The tea industry of Assam is the single largest one of the state playing a dominant role in the economy of the state. It does not only contribute a bigger share in state income but also contribute substantially to the national exchequer every year in the shape of foreign exchange earnings through its exports. Assam tea is not yet officially recognized as a brand or variety of tea by the government due to bureaucratic red tape, depriving the beverage of an exclusive label. As such this industry suffers from an identity crisis in the world market in the absence of official recognition as a unique variety. Moreover, a considerable number of tea gardens of the state have gone sick over the period due to age old gardens, scanty rainfall, increasing trend in the cost of production, general fall in the price of tea, rise in the bed of Brahmaputra, frequent pest attacks, lack of infrastructure, modernization, lukewarm attitude of the tea planters to the tea garden labourers and inefficient management. The demand of Assam tea is already in recession due to better quality tea supplied by the countries like Sri Lanka, Cuba, Kenya and China. India’s tea market is facing yet another paradox which could be explained in terms of glaring gulf between the price received by producer and the price charged by dealers and retailers mainly because of unregulated market behaviour.

Plantation and farm efficiency, growth of total factor productivity (TFP) and its decomposition, and the question of how to measure them, is an important subject in developing countries' agriculture (Shah, 1995; Hazarika and Subramanian, 1999). The present study attempts to estimate the growth of TFP along with the bias in technical progress on the one hand, and firm level technical efficiency and its determining factors on the other, in the tea industry in Assam on the basis of firm level panel data. Industry level time series data are used to analyse TFPG at the industry level. The study period chosen is 2001 till 2010.

Tea producers of prominent tea growing districts in upper Assam, viz., Golaghat, Jorhat, Sibsagar, Dibrugarh, Tinsukia, and those of the three districts of Barak valley are selected for this purpose. The present study also contrasts tea producers of upper Assam districts with those of Barak valley districts in terms of TFPG and efficiency change at the firm level. Distinction of technical progress or technological improvements over efficiency improvements (if any), is another important aspect of the present study (Nishimizu and Page, 1992).

The objectives are arranged for convenience of the research.

(1) To study total factor productivity growth (TFPG) patterns in the tea industry in Assam.
(2) To study rate of technical change and its bias with respect to inputs.
(3) To study elasticities of output with respect to inputs and the scale elasticity of output.
(4) To examine the trend and distribution of firm level technical efficiency.
(5) To estimate firm level cost efficiency.
(6) To contrast the productivity and efficiency patterns of tea producers of Upper Assam compared to those of Barak Valley.

Chapter Two

Review of literature

The concept of stochastic frontier analysis (SFA) originated with two joint papers published almost simultaneously by Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977). The two papers were very similar in their approaches. In the same year a third paper on stochastic frontier analysis was developed by Battese and Corra (1977). These three original SFA models shared a composed error structure and each was developed in a production frontier context. The model can be expressed as $y = f(x; \beta)$. *exp* {v-u}, where y is a scalar output, x is a vector of inputs and β is a vector of technology parameters. The first error component $v \sim N(0, \sigma_v^2)$ is intended to capture the effects of statistical noise, and the second error component $u \geq 0$ is intended to capture the effects of technical efficiency. Thus producers operate on or below their stochastic production frontier $f(x; \beta)$. *exp* {v} according as $u = 0$ or $u > 0$. Meeusen and van den Broeck (1977) assigned an exponential distribution to u. Battese and Corra (1977) assigned a half normal distribution to, and Aigner, Lovell and Schmidt (1977) considered both distributions on u. The parameters to be estimated include β, σ_v^2 and a variance parameter σ_u^2 associated with u. Either distributional assumption on u implies that the composed error $(v - u)$ is negatively skewed and statistical efficiency requires that the model be estimated by using maximum likelihood method. After estimation an estimate of mean technical efficiency in the sample was provided by $E(-u) = E(v - u) = -\sigma_u\sqrt{\frac{2}{\pi}}$ in the normal-half normal case and by $E(-u) = -\sigma_u$ in the normal-exponential case.

Jondrow, Lovell, Materov and Schmidt (1982) proposed that either the mean or the mode of the conditional distribution [$u_i / v_i - u_i$] would provide estimates of the technical inefficiency of each producer in the sample. This procedure of obtaining producer specific estimates of technical efficiency have greatly enhanced the appeal of stochastic frontier analysis. The half normal and exponential distributions assigned to the one sided inefficiency error component are single parameter distributions. More flexible two parameter distributions for the inefficiency error component were also introduced. Greene (1980a, and b) proposed a gamma distribution and Stevenson (1980) proposed both gamma and truncated normal distributions for the inefficiency error component. Even a more flexible distribution, namely, the four parameter Pearson family of distributions, was proposed by Lee (1983).

Reversing the sign on u, a methodology for estimating a stochastic cost frontier model along with firm specific cost inefficiency was first developed by Schmidt and Lovell (1979, 1980). However a deterministic cost frontier model was constructed and estimated by Forsund and Jansen (1977). Greene (1980b) and Stevenson (1980) introduced two parameter distributions for the one sided error component.

Important empirical contributions in the field of measurement of productivity and efficiency and its empirical applications in the tea industry are due to Hashim and Dadi (1973), Ahluwalia (1985), Goldar (1986), Little, Mazumder and Page (1987), Baruah (1987), Balakrishnan and Pushpagandan (1994), Coondo, Neogi and Ghosh (1993), Pradhan and Barik (1995), Ramaswamy (1999), Onjala (2002), Kumar and Jha (2005), Dash, Kabra and Singh (2010), Battese and Coelli (1991), Kumbhaka (2002), Baten, Kamil and Haque (2009), Shumet (2011), Bora (1991), Hazarika and Subramanian (1999), Maity (2011) among many others.

Chapter Three

Models methodology and data

3.1 Econometric Approach

The present study uses appropriate indexes of TFPG under parametric and non- parametric approaches. In particular the study has estimated TFPG using the Solow Divisia Index, the Tornqvist Index, and the Kendrick Index among the parametric measures, and has further estimated TFPG by using the well-known non-parametric measure of the Malmquist Index.

Measurements of technical and cost efficiencies are also done. Production and cost frontier based econometric approaches are adopted for the purpose of measuring technical efficiency as well as cost efficiency at the tea estate level. Both time invariant and the time varying models of technical efficiency are estimated by using the well-known technique of the stochastic production frontier model adopting a time varying transcendental logarithmic production function for panel data. The well-known time varying stochastic production frontier model developed by Battese and Coelli (1992) has been adopted in the study as because it allows the statistical tests of a host of parametric restrictions on the error distribution. Different parameter restrictions imposed in the Battese and Coelli (1992) model generate different stochastic frontier models starting with the most rudimentary model of Aigner, Lovell and Scmidt (1977). Whether the given data follows any particular type of error structure (of the inefficiency random variable) can be statistically tested by the use of likelihood ratio test. The estimates are done using FRONTIER 4.1 for Windows.

3.2 Data

The present study has used secondary data primarily from two sources. (i) Annual Survey of Industries: *Summary Results for Factory Sector* (various issues)in order to get industry level long run time series data on Tea Manufacturing for the period 1981 – 2009 (NIC – 2001, 5 Digit Classification Code: 22710), and (ii) Annual Balance Sheet information as per CSO (Central Statistical Organisation) format at the estate level, submitted to the Tea Board of India on an annual basis. The study period is 2001- 2010. The analyses on estate level performance, productivity and technical efficiency is based on a sample of 31 tea estates (17 from upper Assam and the remaining from the three districts of Barak Valley) of Assam. The selections of the tea gardens or estates have been done on the basis of convenient sampling. The sample for the present study is thus non-random but covers both the major agro-climatic regions of Assam. Factory sector time series data at the industry level has been used to estimate and analyse TFPG for the state of Assam during the period 1981-2010.

Chapter Four

Empirical Results and Analysis

The study finds that In case of Solow Divisia Index the mean TFPG for all estates (n=31) turns out to be 0.58. The mean TFPG for all estates turns out to be negative at -0.87 and 0.57 for Tornqvist Index and Malmquist index respectively. The standard deviation is more for Tornqvist and Malmquist Indexes but less for Solow index. Thus greater variability in TFPG is observed in case of Tornqvist and Malmquist Indexes. The simple correlation coefficient between the Solow measure and the Tornqvist measure is computed at 0.65 which positive as well as statistically significant. The same correlation figure computed for Solow and Malmquist measures turn out to be 0.03 which is positive but close to zero and statistically insignificant. The corresponding correlation figure between Tornqvist and Malmquist index turns out to be 0.09. This shows that the two parametric measures are strongly positively associated while the parametric measures are not associated with the non-parametric measure. The most commonly observed statistical finding is that area under cultivation or land is the most significant factor for the production of green leaf. Although practically labour is perhaps the single most important factor of production in tea plantation, its statistical significance in ordinary regression analysis is very small. This is slightly unexpected.

From the comparison of upper Assam and Barak valley estates it is evident that all measures of TFPG provide higher values for upper Assam. Thus it is perhaps correct to state that upper Assam estates are better performers when it comes to total factor productivity growth.

For the industry level TFPG analysis (using alternative measures), both for the state as well as for the all India level, gross value added is taken as suitable measure of output. At the national level, it has observed that during the first phase of weak liberalisation (1981-85) both Solow and Tornqvist divisia indices are found to be negative, while the Kendrick index and the translog rate of technical change are found to be positive. For the second phase of weak liberalisation, observations are very similar to that of the first regime. However in the second phase of weak liberalisation (1986-1990) TFPG is slightly lower compared to regime 1. During the first phase of strong liberalisation (1991-95) TFPG is both positive and high and all the measures give comparable values. It seems that economic reforms, or otherwise what is known as economic liberalisation, seems to have a significantly positive impact on TFPG. During the second half of the 1990s, TFPG fell slightly but still remained positive according to all the alternative measures, Kendrick index showing the highest value.

However, in Assam average TFPG is clearly higher during the post 1991 period compared to the same for pre-1991 years – an observation that is very similar to the all India TFPG results. The similarity in the TFPG patterns for the tea processing industry in Assam (state level) and for the all India level is not surprising. The simple reason is that the share of tea (processed tea) production of Assam in national tea output has been around 50 – 55 per cent so that the productivity behaviour of tea manufacturing in Assam and the all India level is bound to be similar in many ways.

As far as the elasticities of output with respect to factors is concerned, output is found to be most elastic with respect to fixed capital, i.e., machinery followed by energy and labour at the all India level. Interestingly there is not much of a fluctuation in the elasticities of output with respect to inputs across regimes. The scale elasticity of output is consistently above unity. This is indicative of increasing returns to scale in tea processing at the all India level. However, observed output sensitivity with respect to power in tea processing in Assam is lower compared to that at the national level. From the analysis of the decomposition of output growth (gross value added is taken as a proxy for output), it is observed that the performance of the tea processing industry as a whole has not been satisfactory in terms of TFPG. The entire decade before the period of strong liberalization (1982-90) exhibited negative TFPG but there was a sharp recovery during the first five years of strong liberalization. This almost continued during the second five years as well but declined sharply during the period 2001-05. In terms of TFPG this is clearly the worst phase for the tea processing industry in India. However during the last sub-period there was a slight recovery although TFPG was still negative. The first two sub-periods show positive factor contributions but negative contribution of TFPG to growth of gross value added (GVA). The same is true for the second sub-period as well where TFPG fell further along with value added growth. However during the first phase of strong liberalization both the contributions of capital and labour are negative and both TFPG and output growths are positive and satisfactorily high. Share of capital is never negative. So this is possible only if growth of capital stock is negative during this sub-period. The negative contribution of capital continued during the next sub-period although contribution of labour was positive. TFPG fell sharply during 2001-05. This could well be due to the heavy growth of capital over this sub-period. Growth of value added remained stable for the tea processing industry in Assam over the study period all throughout the post 2001 years. TFPG recovered slightly but was still negative during the last sub-period. During the first phase of strong liberalization or regime 3, both capital and labour registered negative growth rates but the growth rate of labour was smaller than that of capital. GVA growth recovered during regime 4, although growth rate of capital stock was still negative and labour grew positively. During regime 5, there was a very sharp growth of capital stock surpassing all other variables. Although there was a recovery in GVA growth during the last regime capital stock growth was the fastest. Broadly, energy growth has never been negative which is expected in the factory sector or the processing sector. Higher degrees of mechanization lead to labour displacement in the factory sector but the process becomes more energy using. Thus it is expected that energy growth would be higher than labour growth on the whole.

At the all India level technical progress in tea processing was biased against labour and energy in regime 1, but the pattern of bias changed in favour of labour and energy and against capital in regime 2. However the bias amounts are very low. During the first phase of strong liberalization capital bias became negative while technical progress was still biased in favour of labour and energy. However during the post 2001 period, technical progress became biased against labour and energy and went in favour of capital. Thus during the last decade or so there is a hint of energy saving type of technical progress. In case of Assam, the observations are more or less similar with low quantity of bias in absolute terms, and exhibiting labour and energy saving type of technical progress towards the end years. In fact technical progress is also found to be of capital using type during the last decade.

Whether the given data follows any particular type of error structure (of the inefficiency random variable) is statistically tested by the use of likelihood ratio test. In the case of the null hypothesis of no technical inefficiency in the data or absence of the inefficiency random variable from the composed error structure (which is further equivalent to an average production function estimation by use of OLS), it is found that the traditional translog production function indicating the absence of the inefficiency effects is statistically an inadequate representation of data on the inputs and output of selected tea estates of Assam over the study period. Hence it can be inferred that there is a technical inefficiency effect in the data and variations in observed output are not due to random shocks alone. The null hypothesis of the time varying Cobb-Douglas frontier model is rejected and a time varying Cobb-Douglas production frontier model would be an inappropriate representation of the underlying relationship between inputs and output of the selected tea estates of Assam over the study period. The hypothesis of the time invariant Cobb-Douglas stochastic production frontier model is also rejected by the data at 5 per cent level. Thus both the time varying and time invariant versions of the Cobb-Douglas model are inappropriate functional forms and do not represent the technological relationship exhibited by the data on inputs and output of the selected tea estates of Assam over the period 2001-10.The hypothesis tests for the absence of time varying technical inefficiency or for time invariant technical inefficiency under the restriction $\eta=0$, is accepted at 5 per cent level. Accordingly for the selected tea estates of Assam for the study period, technical inefficiency is not significantly rising over time or is insignificantly rising over time (since estimated $\eta>0$). On the whole the selected tea estates of Assam have not been able to raise their levels of technical efficiency over the study period.

Finally the restriction $\eta=\mu=0$ [which boils down the inefficiency specification from the Battese and Coelli (1992) time varying model to the time invariant inefficiency effects model with normal – half normal error structure for panel data due to Pitt and Lee (1981)] is rejected at 5 per cent level and is therefore not supported by the data. Thus the overall results of statistical tests of hypotheses reveals that the translog stochastic production frontier (for panel data) with time invariant inefficiency effects with normal – truncated normal composed error structure may be taken as an appropriate econometric representation of the underlying technological relationship between inputs and output in case of the 31 selected tea estates of Assam over the ten year period 2001-10.

The year wise mean technical efficiency of all the sample tea estates covering upper Assam and Barak valley displays that there is a slight tendency of a rise in technical efficiency over time over the period 2001-10 for the sample of tea estates taken as a whole. Alternatively, there is a hint of a decline in technical inefficiency over time which desirable. The average annual exponential rate of growth of annual mean technical efficiency of all sample estates taken together is estimated at 0.4 per cent. As the growth rate of technical efficiency is below 1 per cent during the 10 year study period, it may be termed as unsatisfactory.

The mean technical efficiency for the entire sample of 31 estates (covering upper Assam and Barak valley) over the study period 2001-10, is estimated at 71.77 per cent. Maximum technical efficiency is estimated at 88.57 per cent while the minimum is 51.67 per cent. This is an indication of substantial variations in the level of estate level technical efficiency.

As far as the cost efficiency is concerned, around 30 per cent of the sample tea estates of upper Assam are found to have cost efficiency between 45 and 65 per cent. Around 53 per cent of sample tea estates in the upper Assam region have cost efficiency levels in between 75 and 95 per cent which is desirable at least from the industry level standpoint. In other words majority of the sample tea estates of upper Assam have cost efficiency levels beyond 75 per cent. Mean cost efficiency of all upper Assam estates taken together is 72.94 per cent. There is a wide observed variation between the minimum and the maximum levels of percentage cost efficiency.

The mean cost efficiency for Barak valley tea estates turns out to be just 63.57 which is far lower than the corresponding figure for upper Assam estates. However the inter-estates variations in cost efficiency are lower for Barak valley estates. Thus the distribution of cost efficiency in this region is more even around a lower mean compared to the same for upper Assam tea estates.

Chapter Five

Summary Conclusion and Policy suggestions

The present study measures and analyses total factor productivity growth and technical efficiency in the tea processing industry of Assam over the ten year period 2001-10 on the basis of both primary as well as secondary data.

In particular the study has estimated TFPG using the Solow Divisia Index, the Tornqvist Index, and the Kendrick Index among the parametric measures, and has further estimated TFPG by using the well-known non-parametric measure of the Malmquist Index. Production and cost frontier based econometric approaches are adopted for the purpose of measuring technical efficiency as well as cost efficiency at the tea estate level. Both time invariant and the time varying models of technical efficiency are estimated by using the well-known technique of the stochastic production frontier model adopting a time varying transcendental logarithmic production function for panel data.

In case of Solow Divisia Index the mean TFPG for all estates (n=31) turns out to be 0.58. The mean TFPG for all estates turns out to be negative at -0.87 and 0.57 for Tornqvist Index and Malmquist index respectively. However, it is observed that upper Assam estates are better performers when it comes to total factor productivity growth.

The mean technical efficiency for the entire sample of 31 estates (covering upper Assam and Barak valley) over the study period 2001-10, is estimated at 71.77 per cent. The study also concludes that the time varying and time invariant versions of the Cobb-Douglas model are inappropriate functional forms and do not represent the technological relationship exhibited by the data on inputs and output of the selected tea estates of Assam over the period 2001-10.

5.1 Policy suggestions

On the basis of the key empirical findings, the study suggests the following set of policy suggestions for policy analysts.

Roadway and railway communication of Barak valley with the rest of India, especially the tea auction centres Guwahati and Kolkata, is extremely gruesome even today. From the standpoint of smooth functioning of the tea industry transport and communications is too vital to be ignored. These issues related to transport and communications infrastructures in the north east need to be addressed at the state level by the state leadership rather than by tea research scientists and estate managers or estate owners.

The provision of uninterrupted or dedicated power to the tea factories can potentially lower the cost structure and may enable smoother running of the tea production process. According to most estate managers the power supply situation of upper Assam is significantly better compared to that of Barak valley. This is one of the reasons why most estate managers believe that use of coal in upper Assam tea processing is much lower compared to Barak valley.

5.2 Drawbacks and Possible extensions

Admittedly any econometric study based on firm level empirical data is bound to suffer from certain limitations or drawbacks. These lacunae or gaps may either be theoretical (i.e. conceptual) or empirical (i.e. either statistical/econometric or data related).

First, the study considers a limited number of tea estates both for Upper Assam and Barak Valley in relation to the population of tea estates in both the zones. Ideally the study should have been based on a representative sample of 70 tea estates (around 45 tea estates from upper Assam and 25 from Barak valley). However, non-responsiveness of the management staff of around 60 per cent of the tea estates has reduced the sample size for the present study considerably. A larger cross-section would have provided statistically superior estimates of parameters.

Second, a longer time period could have been selected, especially a decade before the onset of economic reforms programme of 1991 could have been considered for statistical robustness as well as for profound economic policy implications. Such a data set could have enabled a comparison of the productivity and efficiency trends between the pre-reform and the post-reform years. In other words impact of reforms on the trends of efficiency and productivity in the tea industry of Assam could have been studied from such a data set covering both pre-reform and post-reform years.

Third, the same tea estate produces and sells green leaf as well as processed tea. Thus, a multiple output stochastic production frontier and TFPG should have been adopted.

Fourth, detailed information on input prices could not be collected. Input prices are vital from the point of view of estimating allocative efficiency and hence to estimate a more flexible cost frontier. Simultaneous estimation of technical, allocative and scale efficiencies would have provided a deeper picture of overall economic efficiency at the estate level.

Fifth, quality of manufactured tea as captured by auction price should have been considered as a performance indicator. This variable has not been used anywhere in the analytical part.

If some or all of the above aspects are incorporated in future research works then it would obviously make the study more comprehensive with deeper policy implications.

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